ARCHAEOLOGICAL SPATIAL VARIABILITY ON BRIBIE ISLAND, SOUTHEAST QUEENSLAND

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The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. The material has not been previously submitted, either in whole or in part, for a degree at this or any other university.

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ABSTRACT

Aspects of a hypothetical model of Aboriginal subsistence and settlement on Bribie Island, Southeast Queensland were tested by a technological analysis of stone artefacts. The original model posited movement over the island north-south along the remnant Pleistocene dune system, with limited west-east movement where swamps did not present a barrier. It also posited that groups coalesced and dispersed in response to varying stimuli; and that the two largest sites were semi-permanent residential areas as well as major import points for stone. As stone does not naturally occur on Bribie Island raw materials (and perhaps finished artefacts) were imported. A number of assumptions were made concerning the nature of spatial patterning of artefacts and raw materials relative to hypothesised import points. These included correlations between distance from import points and raw material variability, reliability of raw material, variability in artefact technical categories, and relative artefact size. Analysis results refuted these assumptions. No patterns relating to the import of raw materials and/or artefacts were revealed. The two large sites could not be identified as stone import points on the basis of a distance-decay model. However, statistically significant differences were demonstrated between whole flake and core attributes on the eastern and western sides of the Island, suggesting differential use of the eastern and western dune ridges. A reanalysis and explanation of Aboriginal settlement based on the archaeological data and consideration of the Aboriginal socio-cultural networks throughout Southeast Queensland is presented.

In some ways this is the most difficult part of the thesis to write. For many reasons this study has taken an inordinately long time to come to fruition. There are consequently lots of people to thank for helping me through the ups and downs.

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CHAPTER ONE INTRODUCTION

Introduction

In this thesis I use a technological analysis of stone artefacts to test aspects of a hypothetical model of Aboriginal settlement on Bribie Island, Southeast Queensland. In this chapter I introduce the research context, research questions, and rationale. I also present the methodological background, and outline the thesis organisation.

Research Context

In the late 1970s Dr Jay Hall of The University of Queensland established the Moreton Region Archaeological Project (MRAP), a long-term multi-stage regional project to co-ordinate archaeological investigations in southeast Queensland (Hall 1980:79-83; see also Hall and Hiscock 1988). The Moreton Region lies in the extreme southeast corner of Queensland, covering an area of approximately 21, 400km^2. It is ringed on three sides by mountains from which rivers drain towards the coast through alluvial valleys and coastal lowlands (Hall and Hiscock 1988:4). For research purposes the study area was divided into two sub-regions: the subcoastal zone including the Brisbane River drainage west of the Beechmont and D'Aguilar Ranges to the Great Dividing Range; and the coastal zone incorporating the coastal lowlands, the offshore islands, and Moreton Bay (Hall and Hiscock 1988:4-6). Initially the objectives of MRAP were to systematically locate and record sites in the Moreton Region, characterise the archaeological record, and collect and analyse sufficient data to develop a cultural chronology and reconstruct prehistoric cultural patterns (Hall 1980:81). By 1988 the MRAP objectives had extended to a systematic study of the stone artefact component of the archaeological record, as stone artefacts may provide 'the most powerful and reliable medium with which to link the archaeological record with higher level theories about prehistoric human behaviour' (Hall and Hiscock 1988:16). One area of interest was the potential for reconstruction of stone procurement and settlement systems (Hall and Hiscock 1988:17).

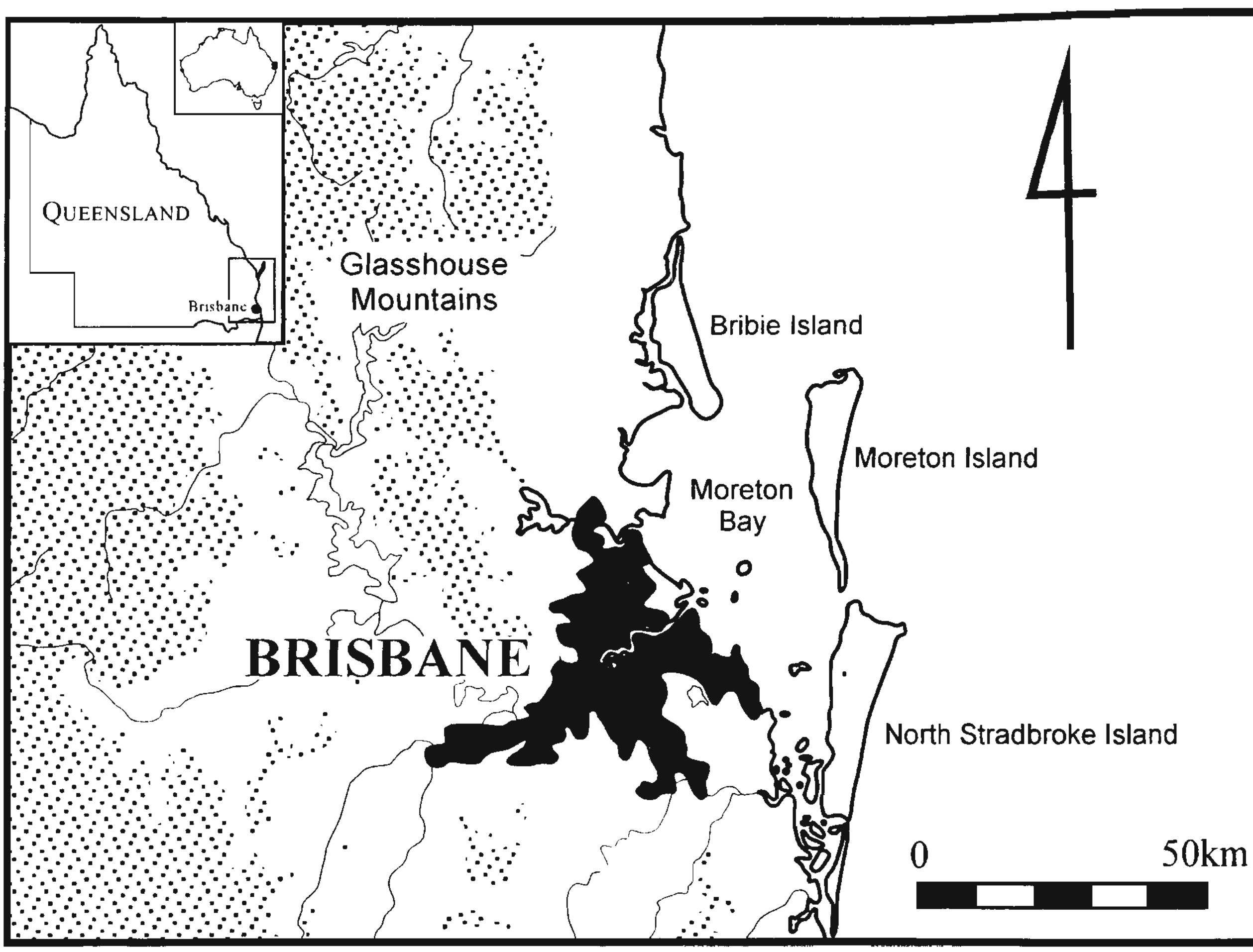

Figure 1.1 Coastal Zone of the northern Moreton Region (map courtesy of Sean Ulm).

Bribie Island is in the coastal zone of the Moreton Region. and is the northernmost island in Moreton Bay. MRAP began work on Bribie Island in 1981-82, and in the early 1990s the Bribie Island Forest Archaeological Project (BIFAP) was set up under the MRAP umbrella. BIFAP was originally intended as a vehicle through which more comprehensive studies of the sites on Bribie Island could be undertaken. Subsequently it has investigated and assessed the impact of logging operations on the archaeological record of the Island.

Over the last 30 years more than 120 sites have been recorded on Bribie Island (BIFAP files, School of Social Sciences, The University of Queensland; Crooks 1982; Hall *et al.* 1991; MRAP files, School of Social Sciences, The University of Queensland; Smith 1992; Stockton 1973). In the early 1970s 30 middens on the western coast bordering Pumicestone Passage were recorded (Crooks 1982; Stockton 1973). Crooks (1982) analysed stone artefacts casually collected by a local resident, Mr. Ted Clayton, from deposits eroding on to the beach at White Patch and identified 439 flakes, 500 cores, 474 flaked pieces, 95 bevelled artefacts, and 334 manuports.

Hall redressed the concentration on coastal sites by initiating a large-scale survey of the interior of the Island as part of MRAP in 1981-1982. Sixty-nine sites including midden and artefact scatters were recorded, the majority on or abutting the firebreaks in the commercial pine plantation (MRAP files, School of Social Science, The University of Queensland). These firebreaks generally follow the higher areas of the north south trending Pleistocene dune ridges (see Chapter Three). Analysis of the shellfish remains at the sites across the Island indicated that the majority were estuarine species (i.e. those found in Pumicestone Passage). Species from the high energy surf beach on the eastern coast (e.g. pipi or eugarie, *Donax deltoides*) were found in relatively greater numbers in the eastern sites, less so in the western sites (Smith 1992).

Locating sites within the pine forest away from the firebreaks had been problematic due to the poor visibility resulting from the carpet of pine needles. Between 1996-1999 I identified and recorded a further 21 midden and artefact sites within the exotic pine plantation (BIFAP files, School of Social Science, The University of Queensland), employing the predictive site location model I developed (Smith 1992) and raking possible target areas.

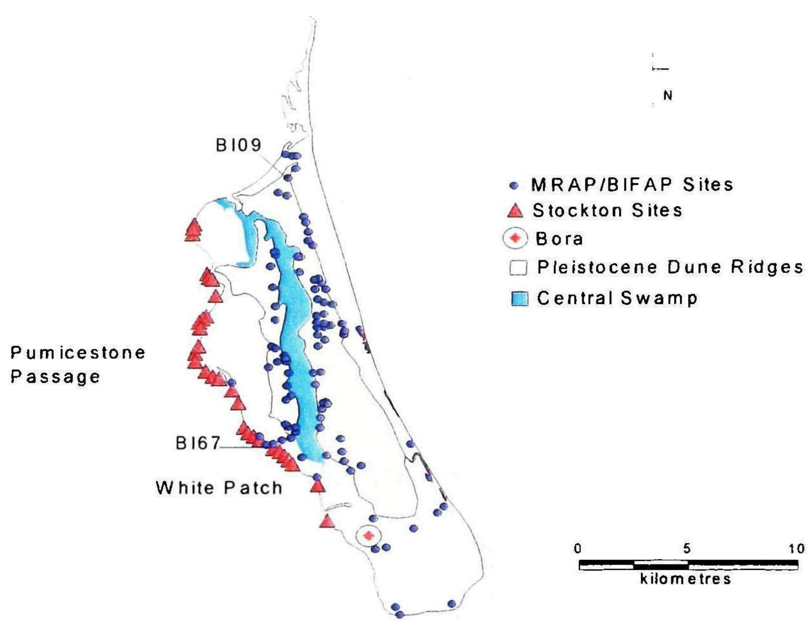

Figure 1.2 Composite map of Bribie Island sites

Research questions

I undertook a technological analysis of a stone artefact assemblage from Bribie Island in order to answer questions about Aboriginal settlement subsistence patterns raised by the results of my Honours thesis (Smith 1992). The Honours study characterised the archaeological record of Bribie Island, developed and successfully tested a predictive model of site location (multivariate analysis showed only one aberrant site out of 71 in the study) and proposed an explanation for the archaeological variability in terms of subsistence and settlement. While the stone artefact assemblage was considered in determining settlement patterns on the Island, the study was principally based on shellfish remains (Smith 1992).

The hypothesised model of Aboriginal settlement was one of entry or import points through the two largest sites on the Island, BI09 in the north and BI67 in the southwest which I inferred to be major base camps. Associated with these base or large-scale semi-permanent residential camps were smaller sites considered to be the result of movement up and down the Island's dune system by small family groups, or specific activity groups such as hunting parties. I decided that an analysis of the stone artefact assemblage could test this hypothesis. As stone does not occur naturally on Bribie Island, stone raw materials for the assemblage must have been imported.

Australian and international studies have demonstrated aspects of raw material rationing as the distance from the source increased. In the case of Bribie Island, import points may be argued to be the source or sources of raw materials (and perhaps artefacts). The proposition is made that, as distance from the import points increases, particular characteristics will be noted in the artefact assemblage. For example, at or near the import points, there will be:

- a relatively greater variety of raw material types;
- a relatively greater number of each artefact category; and
- relatively larger artefacts.

At increasingly greater distances from the import points, there will be:

- less variation in raw materials
- a relatively greater proportion of the more reliable raw materials;
- less variation in artefact categories; and

- relatively smaller artefacts.

My research questions therefore consider the following:

- Does raw material usage on Bribie Island exhibit patterns of spatial variation?
- Do stone artefacts on Bribie Island exhibit spatial variation in size, artefact categories or in the proportion of both size and artefact category?
- Is the hypothesis of import sites supported, and, if not, how can the pattern of sites on the Island be otherwise explained?

Rationale

Bribie Island provides a unique opportunity for studying the stone technology of a discrete, circumscribed area within the larger Moreton Region. As the Island has no source of knappable stone, all stone found on it must be imported. It is ideal for testing raw material rationing or distance from source-decay against a background of assured plant and animal resources, and a tested model of site location. The study also provides the opportunity to apply the stone analysis to interpretations of mobility and sedentism of Aboriginal groups around Moreton Bay (see Hall 1982, 1987, 1991; Nolan 1986; Walters 1987).

Methodological Background

There are two basic kinds of stone artefact analysis and classification; typological and technological. Typological analysis and classification focuses on distinctive or specific implements ('tools'), which are usually some form of retouched flake. Until the 1970s, most stone artefacts were categorised using typological classifications, often implying function; that is, they were classified as axes, adzes, blades, points, burins, scrapers etc. The classifications were often arbitrary, based on perceived morphological characteristics and inferred function, and specific only to particular assemblages. Examples of these kinds of classifications are the African Oldowan and Acheulean typologies, the European Acheulean and Mousterian typologies, and the New World Folsom and Clovis typologies (formalised in e.g. Bordes 1961, 1968; Leakey 1961; Wilmsen 1978). These influenced early Australian classifications proposed by Kenyon and Stirling (1900), Kenyon (1927) and Howchin (1934) within which functional descriptions were made on the basis that implement form indicated function (see Hiscock 1998:260). Subsequent classifications proposed by McCarthy, Bramell and Noone (1946), McCarthy (1967) and Mitchell (1949) were based on morphological distinctions, while still retaining the view that implement classes reflect functional classes (Hiscock 1998:260).

Common factors in traditional typological analyses include:

- a focus on morphology and relative abundance of traditionally recognised implement types;
- presumption that manufacture is directly influenced by intentional design, production and use of functionally specific tools;
- dismissal of informal or functionally non-specific artefacts as waste; and
- presumption of function based on morphology.

Problems inherent in traditional typological analyses include their limited ability to inform on changes in manufacturing behaviour; a lack of technical understanding of artefact manufacture; a high degree of subjectivity; and the employment of classifications or categories which do not include or consider all artefacts at a site or in an assemblage. For example, in studying the stone artefacts from Kenniff Cave, Mulvaney generally followed McCarthy, Bramell and Noone's basic classification of implement types (1946). He wrote:

> One difficulty with classifying an Australian collection lies in the amorphous nature of many of the quartzite and quartz industries, which makes them less amenable to treatment in the sophisticated European style. It is possible, on the other hand that even some contemporary European typological and metrical procedures fail to take account of the full complexity of the potential sample (Mulvaney and Joyce 1965:174).

Referring to apparently unworked flakes he adds, 'These random and use-fractured objects are unclassifiable under any canon of typological procedure. Yet it would be quite misleading to ignore the reality of such nondescript items' (Mulvaney and Joyce 1965:175).

In analysing stone artefacts from the west coast of Bribie Island, Stockton (1973) attempted to classify artefacts on the basis of the McCarthy (1967 in Stockton 1973) system, and that developed by Haglund (1968 in Stockton 1973). He found both to be problematic, as there was no direct basis for comparison (Stockton 1973:87-88).

Bradley (1975) sought to establish a glossary for reduction sequences within a typological framework within which interpretative potentials are increased. While valid in their context, his comments exemplify the weaknesses of typological classifications.

> 'This (specific) assemblage should have an identifiable implement typology and lithic reduction sequences. Deriving this information is not always easy and in some cases virtually impossible. Identification of the implements can be approached functionally, typologically, and ethnographically' (Bradley1975:6).

Examples from Bradley's proposed glossary further highlight the subjective assumptions underlying many typological classifications:

> Blank: any piece of lithic material that has been modified to an intended stage of lithic reduction in a specified assemblage. It must be demonstrable that it is not a finished implement and that it is intended for further modification. *Furthermore it must have the morphological*

> *potential to be modified into more than one implement type within the assemblage*. The method of its manufacture is not important in its initial identification (Bradley1975:5, emphasis added).
>
> Preform: any piece of lithic material that has been modified to an intended stage of lithic reduction in a specified assemblage. It must be demonstrable that it is not a finished implement and that it is intended for further modification. *Furthermore it must have the morphological potential to be modified into only one implement type within the assemblage*. The method of its manufacture is not important in its initial identification (1975:6, emphasis added).

Over the last 30 or 40 years there has been a trend towards the use of technological analyses to explain assemblage composition, variability, spatial patterning, and function as well as settlement patterns and mobility. In some ways this trend has been a return to the late 19th century view expressed by Holmes that lithic analysts were concerned with, (among other things) reconstructing the processes involved with acquiring lithic raw material, shaping stone tools, and using them; outlining the evolution of the form and function of groups of stone tools through time; and treating stone tools as historic records that can be used to address questions of time, questions of culture, and questions about the history of peoples (Holmes 1894, cited in Yerkes and Kardullas 1993:96).

The trend toward technological analyses was in part due to ethnographic observations on stone tool manufacture and use (e.g. Gould 1969; Gould *et al.* 1971; Hayden 1977; O'Connell 1977; White 1967), which 'demystified' the process. Hayden described his 'emotional disappointment to actually see stone tools being used in traditional ways. The feeling of 'is that all there is to it?' was uncomfortable' (Hayden 1977:179). Some of Hayden's surprises included:

1. Stone artefacts may have been treated in a totally profane manner by their makers;
2. Formal implements may be poor indicators of the range and frequency of artefact use in an assemblage. Implements may constitute only a small proportion of the

artefacts actually used, and a number of different morphologies could all be employed for the same function;
3. Retouching is often a means of rejuvenating a dysfunctional edge, rather than an attempt to produce the ideal form from the outset; and
4. Factors that condition the form and abundance of retouch need to be better defined, but are most likely to involve raw material properties, raw material availability, and the form of hafting (Hiscock 1998:257-258).

Australian and overseas studies employing technological analyses that are directly relevant to this thesis include those of mobility; raw material availability and procurement; and debitage analysis (e.g. Bamforth 1986, 1990; Burton 1980; Byrne 1980; Gould and Saggers 1985; Hiscock 1986, 1988, 1996, in press; Kuhn 1994; McNiven 1990, 1994; Parry and Kelly 1987; Shott 1986; Sullivan and Rozen 1985; Torrence 1983). A selection of these studies is reviewed in Chapter Two.

The limitations of traditional typological analyses do not permit my research questions to be answered. I consider technological analysis to have certain traits that will allow their solution:

- it is based on ethnographic observations of artefact manufacture and use;
- the categories do not imply function;
- it allows for examination of the entire assemblage;.
- it identifies technological features that are not assemblage-specific;
- the opportunistic aspects of artefact manufacture are recognised;
- specific questions about human behaviour may be answered;
- explanatory models of human behaviour may be developed;
- reduction systems are described;
- there is a reliance on understanding of processes of artefact manufacture; and
- it is objective.

Thesis organisation

In this chapter I introduced the research questions. Chapter Two reviews literature concerning subsistence-settlement studies, technological stone analyses particularly related to artefact manufacture, raw material availability and procurement, debitage analysis, assemblage composition and variability, and mobility. Chapter Three describes Bribie Island's physical characteristics, including vegetation, fauna, geomorphology and hydrology. Chapter Four provides an ethnohistorical background and historical accounts of the behaviour of the Bribie Islanders and other Moreton Bay Aborigines. These chapters help to inform the discussion of settlement and mobility patterns in Chapter Seven. Chapter Five describes the technological analysis methods and methodology and Chapter Six presents the results. Chapter Seven presents the results and their implications for the hypothesised import site model. Also in Chapter Seven are presented the conclusion, and recommendations for future research.

CHAPTER TWO STONE LITERATURE REVIEW

Introduction

> Although archaeologists have asked flaked stone tools to answer many different questions over the past 30 or 40 years, we have always assumed that these artefacts are capable of answering those questions (Bamforth 1990:71).

This chapter is not a full history of stone analysis - an almost impossible task, and far beyond the scope of this thesis. I stated my reasons for choosing technological analysis over a typological analysis as an appropriate tool for the Bribie Island assemblage in Chapter One. Those reasons are not explained further here. Rather I review stone analyses that have informed the research on Bribie, essentially discussing technology, stone and settlement, mobility, raw material procurement and distance decay/rationing, and how these may manifest in the archaeological record. Given the mass of literature available I have attempted to keep the review as concise as possible.

SOME BASICS

Ethnographic observations and a few re-evaluations

Hayden's work with older members of the Pintupi, Yankuntjara and Wangkayi communities in the Western Desert, focused on 'less well documented and less well known hand-held tools' (Hayden 1977:179). He noted that what archaeologists called 'tools' were relatively rarely manufactured. '...unretouched primary flakes were used for shaping and scraping wood, and unmodified blocks of stone for chopping wood. None of these would have been recognised archaeologically as 'tools' (Hayden1977:179) (from Hayden's comments I infer 'primary flake' to mean one that has simply been struck from a core rather than a flake whose dorsal surface is entirely covered by cortex). Earlier researchers had also noted this lack of retouched tools (e.g. Gould *et al.* 1971). Hayden (1977:179) recalled a verbal comment from Bordes: 'a stone flake is sharpest right after it has been removed from the core; any secondary retouch will only make it duller'. Only in special cases were flakes retouched, '...the more common reaction was to look over the primary flakes that had been struck from the core, for a more suitable flake for the work at hand, or to remove several more...until a suitable one was knocked off' (Hayden 1977:179).

Hayden observed that some retouched pieces were almost immediately discarded as the retouch had rendered the working edge unsuitable. On other occasions, however, resharpened pieces would be satisfactorily used.

> It should be emphasised that this secondary retouch was done with the aim of 'resharpening' or rejuvenating a dulled working edge into a more suitable one. There was no indication of any overall morphological ideal type, 'classic' form, or 'perfect' specimen, as collectors are wont to say, and as archaeologists often tacitly accept in conversation. Rather the traditional attributes of importance in the Western Desert were: effective edges (which were surprisingly variable in morphological expression), and a suitable size for holding in the hand and exerting pressure (Hayden 1977:179).

There was no shortage of raw materials for the technological projects on which Hayden's informants worked. When and where raw materials might be scarce, more primary flakes might exhibit retouch although this could also depend on the type of raw material and the task for which it was used (Hayden1977:180).

One of Hayden's observations, which contributed to his surprises, epitomises the archaeological and cultural concepts of the time:

> ...there were no master craftsmen of stone tool making (this may not have been strictly true of the Warramunga or Walbiri where prismatic blade knives were produced for trade). No one was as capable of controlling the stone medium to anywhere near the degree attained by the renowned stone knappers in the Occident, such as Bordes. Instead there was only a moderate degree of control over the stone medium; suitable flakes for work were often picked out of almost random flakes. However the flakes that were obtained were perfectly adequate to the technological needs of all task activities. A similar lack of control was noted among the Nakako and Pitjantjatjara by Tindale...and the Ngatatjara by Gould...(Hayden 1977:179).

Hayden, along with others such as Gould (1977; Basedow 1925 in Hayden 1977; Gould *et al.* 1971; Mountford 1941 in Hayden 1977; Tindale in Hayden 1977), had the chance to observe ethnographically the generally opportunistic, profane nature of stone artefact manufacture in Australia. Although 'the idea is perhaps easily accepted intellectually' (Hayden 1977:179) the reality of seeing how little interest people actually had in the stone was another matter. Bordes and the Western Desert knappers were simply involved in two entirely different lithic experiences. Bordes was participating in some 'semi-sacred' act; the Aborigines were just making something useful.

Hayden and his peers did not suggest that all stone artefact manufacture and use is profane, although everyday items fit into that category. Gould *et al.* (1971) recorded a small hafted item called *pitjuri-pitjuri* used for engraving sacred boards and decorated spearthrowers, covered with ochre and hidden when not in use. It was never shown to women, children or uncircumcised men (1971:155). Otherwise there was a simple distinction made between a thick flake that can be trimmed for working wood, *purpunpa*, and a thin flake with a sharp edge suitable for slicing or cutting, *tjimari*. *Tjimari* could be retouched if the cutting edge needed it but in most cases the 'extremely sharp edge of the freshly struck flake is regarded as sufficient' (Gould *et al.* 1971:149).

Small *tjimari* were reserved for use in circumcisions and disposed of after one use. It was forbidden for women, children and uncircumcised men to see these small knives (1971:156). Occasionally *tjimari* were hafted with gum resin; otherwise they were held between the thumb and forefinger for use (including butchering). Usually they were discarded after a few uses, with no resharpening. '...They rarely show much in the way of secondary trimming and could be difficult for an archaeologist to recognise them once the gum handle decomposed' (Gould *et al.* 1971:156).

The continuing value of Hayden's work and that of his peers such as Gould (1977) and O'Connell (1977) lies in the re-evaluation of conventional views of prehistoric implements (Hiscock 1998:257). Hayden himself hoped 'the insights which result from this study will ...help to reorient prehistorians' attitudes and interpretations of what they are dealing with in their study of lithic remains from the past' (1977:178).

A technological perspective

Flenniken and White (1985) provided a comprehensive account of Australian stone artefacts from a 'flintknapper's perspective', based on replicative experiments, inspection of artefacts assemblages, and the literature. They argued that 'preforms' for formal and informal tool types had been manufactured solely by percussion techniques. All these preforms, in Australia and Tasmania, are the result of a single reduction sequence. The technologies used were 'ingeniously simple', 'flexible', 'highly opportunistic' and 'exploited the potential of the reduction sequence in a variety of ways' (1985:131).

The sequence has five stages: selection of raw materials; production of macro-flakes and cores; production of blades and cores; production of micro-flakes and cores; and exhausted cores. Not all stages of the sequence may be found in one place, and a sequence was 'rarely produced prehistorically as a single event from a single piece of stone' (1985:131-132). Six reduction techniques - free-hand percussion, bipolar, percussion bifacial thinning, percussion backing, burination and pressure flaking - are identified. 'All of these techniques employ the same basic knapping principles. None of them imply drastic technical changes such as might have been introduced from some external source...' (1985:132).

Hiscock (1988:38-41) criticised the inability of this and other general reduction sequences to express the dynamics of simple lithic technologies or describe the limits and thresholds of a technology and its range of viable approaches. Holdaway's criticised the sequence for the same lack of change as previous typological studies (1995:791). Certainly it does not account for the changes in Tasmanian technology described by McNiven (1994). In places the Flenniken and White paper does seem a little simplistic, for example in its brief discussion of miscellaneous flake tools, 'the most common artefact 'type' recovered from prehistoric Australian sites. These artefacts possess no common set of diagnostic attributes...their frequency illustrates the opportunistic nature of Australian technologies' (Flenniken and White 1985:148). Only two paragraphs are dedicated to their discussion.

Despite the criticisms the paper is a useful overview of artefact manufacture, and morphology not predetermined by deliberate design. It reinforces the opportunistic nature of Australian stone technologies,

> taking full advantage of whatever the environment offered. By this we do not mean that there was laziness or carelessness, but that stone tools were very largely the result of the least possible effort necessary. If a cortex-backed flake could be used instead of a backed blade, or a naturally triangular pointed flake was available, then these tools were used (Flenniken and White 1985:149).

Debitage analysis - a beginning

The purpose of this section is to provide a brief discussion of two relatively early studies that used debitage analysis as a technique, Burton 1980, and Sullivan and Rozen 1985. In 1978 Fish had observed that the potential for cultural interpretation of the 'humble category' of debitage remained largely unexplored even though it often constituted the majority of lithic artefacts at a site, and sometimes the only type of artefact present (1978:374). By 1994 Shott observed that few archaeologists discarded or utterly ignored the category, although some still decried its ongoing neglect (1994:70). While there is general agreement as to the need for debitage analysis, there are still differing definitions of what constitutes debitage (e.g. Andrefsky 1998; Bahn 1992; Burton 1980; Fish 1978; Shott 1994; Sullivan and Rozen 1985). Interestingly, a recent *Dictionary of Archaeology* edited by Shaw and Jameson (2002) carries no definition of debitage, nor any other terms relating to knapping or stoneworking. Although generalisation is inherently dangerous, in the terms of the international definitions cited above and discussed below, the flakes described by Hayden (1977) and Gould *et al.* (1971) are considered debitage.

Burton's 1980 work examines two Neolithic chipping/working floors at Crickley Hill (earlier Neolithic) and Grime's Graves (a later Neolithic 'axe factory') in southern England in order to characterise the process of manufacture and the production of waste flakes (1980:131-132). These sites were essentially undisturbed. Using multivariate analysis and replication experiments, differences between the sites were identified and statements about the assemblages made. Crickley Hill lacked waste flakes associated with early-stage processing of large flint nodules. Only 4% of flakes present were 'essential to biface manufacture'; the majority were small chips. Burton proposed two possible activities, production of small flakes for use, or secondary manufacture (1980:137 - 138). At Grime's Graves the assemblage was more evenly balanced between small chips and larger flakes, but was not indicative of the roughing out process associated with axe making (1980:137-139). Burton conceded there was possibly a two-stage industrial process, but that technological knowledge alone did not answer the problems of economising judgements. These needed to be integrated into a wider scheme of societal and economic models at workshop and regional levels (1980:139).

Sullivan and Rozen acknowledged that a major problem with debitage analysis was the application of the faulty premise that individual artefact morphology indicates a specific production technique. There were also problems with the use of inconsistent definitions (1985:755-758, 773) (and one could argue that these problems still obtain in certain circumstances). Sullivan and Rozen's 'new approach to debitage analysis' was based on 'interpretation-free categories to enhance objectivity and replicability' (1985:758). Using variables of single interior surface, point of applied force and margins, each with two dichotomous attributes, four debitage categories were defined. These were complete flake, broken flake, flake fragment and flake debris (1985:758-759). Additionally the new approach, a), did not assume equivalent significance of particular variables in all research contexts and, b), as it accommodated 'the full range of formal variation in debitage' allowed the testing of inferences based on differences in proportions of debitage categories (1985:759). Demonstration of the approach was undertaken on two different data sets from two different projects. Similar conclusions were reached in both. Shaped (formal) tool manufacture results in comparatively high and invariable proportions of flake fragments and broken flakes, while core reduction produces relatively high and variable proportions of complete flakes and debris (1985:77). The 'new approach' of 1985 has become the basis of many technological debitage analyses since. However Shott (1994:80) warns that frequent exceptions to the model compromise its value and it should not be employed uncritically. He does however acknowledge, as do I and almost a whole generation of lithic analysts, the salutary effect of focusing archaeological concern on attribute replicability and terminological clarity (Shott1994:79)

SPATIAL ANALYSIS

Raw materials

Embedded procurement?

On the basis of his observations of the mobile Nunamiut peoples, Binford noted:

> Raw materials used in the manufacture of implements are normally obtained incidentally to the execution of basic subsistence tasks. Put another way, procurement of raw materials is embedded in basic subsistence schedules. *Very rarely, and then only when things have gone wrong, does one go out into the environment for the express and*

> *exclusive purpose of obtaining raw material for tools* (Binford 1979:259, original italics).

Binford also drew on his 'limited but enlightening experience with the Alyawara of the central desert of Australia' (1979:260) to conclude that raw material variability at a given site is primarily a function of the scale of the site catchment area. No extra effort needs to be expended to obtain the raw materials. This is a different perspective than that of 'most analysts of lithic remains' who assume a direct set of procurement strategies (1979:260). This almost typically black and white Binfordian pronouncement is explored in two studies, one from Central Australia (Gould and Saggers 1985) and one from southern Illinois (Morrow and Jefferies 1983).

Gould and Saggers essentially agree with Binford's observation that 'raw materials used in the manufacture of implements are normally obtained incidentally to the execution of basic subsistence tasks' (Binford 1979:259) but find his idea of embeddedness overly restrictive and inadequate when considering the archaeological variability of the Western and Central Deserts (Gould and Saggers 1985:117). '...Binford has overstated his position to the point where parsimony approaches reductionism, and we argue here for a more inclusive concept...that harks back to Binford's earlier (1962) arguments...' (Gould and Saggers 1985:117).

Gould and Saggers were further frustrated by Binford's dismissal of technological criteria in the explanation of hunter-gatherer lithic materials. Additionally Binford doubted the usefulness of variables such as distance from source, difficulties of terrain, transport capability, manufacture and artefact utility in evaluating the occurrence of local and non-local stone (Gould and Saggers 1985:118). Small amounts of non-local or 'exotic' chert had been found at Puntutjarpa Rockshelter, even though technically superior local stone was readily available. Ethnoarchaeological observations revealed that men would frequently make special purpose trips (always exploiting edible resources along the way) that were not simply due to emergencies or in response to raw material shortages. The documented trips were to obtain lithic raw materials and mineral pigments, although similar trips were also undertaken to obtain spinifex resin and *Crotalaria* bark for sandal making (1985:120). The majority of the trips were to areas with sacred associations which only men with sacred affiliations could approach. Similar trips were also observed in the Warburton Ranges, where all-male groups would travel hundreds of kilometres to sacred landmarks associated with Dreaming myths. The trips served to renew or establish the networks for use of resources in the areas. Betrothals were also arranged, resulting in long distance in-law relationships with strictly observed mutual obligations. While conceding that distinguishing these different strategies archaeologically is not possible, they serve to remind that social structure and symbolic content are a major adaptive theme in Australian Aboriginal ethnology *(sic)* (Gould and Saggers 1985:121-123). In the comparative James Range East study, technological factors were found to explain the presence of non-local lithic raw materials, which were superior to locally derived materials. The studies broadened the understanding of embeddedness rather than restricting it to the level of subsistence strategies argued by Binford (Gould and Saggers 1985:134).

Morrow and Jefferies used the study of chert tools and debris from the Black Earth site to determine the most likely procurement strategy for non-local chert resources. Black

Earth was a Middle Archaic site occupied on a relatively sedentary, year round basis (1983:27). Earlier Archaic groups were relatively mobile, but during the Middle Archaic became more sedentary with subsistence strategies tied to the seasonal availability of critical plant and animal resources. There was also a reduction in procurement territories and an increase in population (1983:27-28). Local chert resources occurred within 30km of the site, while non-local chert sources were between 60-70km to the southwest (1983:29). Procurement strategies could be reflected in the differential use of the local and non-local cherts e.g. direct procurement or trade strategies would be reflected in extensive reduction of non-local chert tools, use of non-local chert in specialised tool forms, importation of preformed tools, and the use of local chert for expedient tools. In the case of embedded procurement, no differences would be detected in the use and discard of local and non-local cherts (1983:30).

Analysis revealed that the majority of artefacts were of local chert, with only a small percentage of non-local chert artefacts. There was little or no evidence of the early stages of tool production in the non-local artefacts suggesting that they were brought in either as preforms or finished artefacts. However once on site there was little evidence of differential use. Based on the collective evidence, the Black Earth artefacts conformed to the Binfordian notion of acquisition of raw materials within the normal functioning of the system with no extra effort involved in their procurement. Their acquisition was seen as embedded procurement (1983:33). What was not clear was the nature or extent of movement through the landscape by an apparently fairly sedentary group. Morrow and Jefferies acknowledge that, given the non-local cherts came from 70km away, the Black Earth group remained mobile through a relatively large area.

Almost as a throw-away line they add 'although there is evidence of some type of exchange system found at contemporary sites in the Midwest, our study indicates that the Black Earth inhabitants did not acquire chert through an emerging trade network' (1983:33). I am less convinced.

Other procurement strategies

The above studies show that embedded procurement is not as simple as Binford originally implied. There are also other opportunities for procuring raw materials beyond the limited scope proposed by Binford. These may be part of social, ceremonial, symbolic and economic networks, risk reduction and technological and strategies (see Collins 1979). Some of these are discussed below in the contexts of mobility, and distance to source.

Mobility and sedentism

Mobility is a recurring theme in hunter-gatherer studies. Studies were initially concerned with hunter-gatherer mobility relative to exploitation of plant and animal resources. Over the last 20 years or so the concept of mobility and how it may be expressed has been extended to the study of stone artefacts. These include studies of assemblage composition and variation, and raw material availability and procurement. Definitions of mobility, like those of debitage, vary widely and are often restrictive (e.g. Binford 1980). Similarly, there is little agreement as to the meaning of 'curation' (see Shott 1996).

'When ethnographic data are consulted...mobility appears to be a complicated concept, and difficult to define in operational terms. In moving around people change their locations for different purposes, in differing group compositions, and for varying lengths of time' (Ebert 1979:66-67). Despite the difficulties outlined by Ebert, there seems to be agreement at a general level that people who are highly mobile would usually possess a 'toolkit' comprised of lightweight, portable, multifunctional, flexible, and complex implements (e.g. Andrefsky 1994,1998; Binford 1979, 1980; Ebert 1979; Lurie 1983; Shott 1986; Torrence 1983). At the other end of the spectrum, people with low mobility generally possess a 'toolkit' that may be more expediently manufactured and contain less formal implements (e.g. Binford 1979; Shott 1986). The more organised assemblages serve as risk-reduction mechanisms, risk representing the probability of failing to secure resources (Hiscock 1994; Jochim 1981).

Based on the 1974 Ammerman and Feldman model, Shott (1986:19) employed three variables to characterise 'forager' technologies: diversity (number of distinct tool types used); versatility (the number of tasks to which tools can be applied); and flexibility (which increases as the number of task applications increase). This last variable is poorly defined and does not figure prominently in the subsequent analysis. Shott also acknowledges that, with respect to diversity, little data on the actual number of tools used can be found ethnographically (1986:47). After examining a number of 'forager' societal variables, Shott determined that technological diversity is more closely related to mobility frequency (how often a group moves) rather than mobility magnitude (how far a group moves). Conversely, complexity is related to mobility magnitude, albeit with a weaker relationship (Shott 1986:33). Shott suggests that the findings indicate that it is inappropriate to employ mobility as an undifferentiated variable in analysis; the mobility parameters must be specified.

Lurie (1983:46-48) used a technological study to help determine possibilities for increasing sedentism at Koster, a deep stratified Middle Archaic site in the Illinois River valley. It is close to a permanent source of water and seasonally available resources. Carlson

> proposed two major types of hunter-gatherer mobility relevant to Koster; ...*residential* mobility in which small groups of producers and consumers move as a unit through a seasonal round, and...*logistical* mobility in which consumers remain at more permanent base camps for several seasons while small groups of producers procure distant resources and bring them back to consumers. Generally residential mobility is an effective strategy when a variety of overlapping resource zones can be freely exploited by small groups of hunter-gatherers, while logistical mobility is more advantageous when 'a single resource determines site location as a result of abundance or necessity '(1979 in Lurie 1983:48; cf Binford 1980).

Residential mobility patterns comprise a series of residential camps occupied by small groups for a short time while exploiting resources in the vicinity. Logistical mobility patterns comprise base camps, residential camps, and/or extractive camps occupied by larger groups near an abundant resource and occupied as long as the resource is available. Distinguishing archaeologically between residential/base camps and extractive camps depended on the variety of tools present rather than functional differences in tool types. The overall result indicated a change in the degree of mobility, although not all expectations of the study were met (Lurie 1983:50, 55).

There seems to be general agreement within the field of Australian archaeology that sedentism in many landscapes increased in the late Holocene, when risks associated with unfamiliar landscapes and high mobility no longer existed (Hiscock 1994:284). It is beyond the scope of this study to discuss the many reasons underlying the arguments for increased sedentism. However a consideration of how increased sedentism may be reflected in Australian stone technology is important here.

Highly retouched implements including points, backed blades, tulas and eloueras were used throughout the late Holocene, although with a decrease in abundance and proportional contribution to assemblages. If these kinds of implements are perceived as part of a technological risk- reduction strategy, then when that risk is reduced so is the need for that particular type of toolkit. Alternative technological strategies may develop (Hiscock 1994:284-285). It seems that in certain areas of Australia at least there is a correlation between sites indicative of 'high sedentism and highly reduced assemblages containing an emphasis on local stone but comparatively few retouched flakes' (Hiscock 1994:285). Although suggestions have been made that population increase placed restrictions on raw material availability because sources were exhausted or territorial boundaries imposed, Hiscock (1994:286) considers reduction of mobility to be the most likely mechanism for the changes.

In North America Parry and Kelly noted a shift from assemblages dominated by formal tools such as bifaces to 'an almost exclusive use of informal tools struck from unstandardised cores' (Parry and Kelly 1987:285). They proposed that this shift to 'expedient core technology' was a response to decreased mobility (1987:285). Based on ethnographic accounts, characteristics of expedient core technology include:

> First, the flaking techniques are not intended to control the form of the resulting flakes. Cores are not preformed or prepared in anyway.

> Instead, they are struck almost randomly, shattering into pieces of variable size and shape. A bipolar technique is often used: the core is set on an anvil stone and smashed with another rock, with all the finesse of a man cracking walnuts. Such flaking techniques require no training or practice, and relatively little effort is expended (Parry and Kelly 1987:287).

Other characteristics are that there is no distinction between 'tool' and 'waste' - every piece is regarded as a potential tool and the pieces best suited for the task at hand are chosen for use (Parry and Kelly 1987:287). Tools are seldom modified, being discarded rather than retouched or resharpened. 'Most tools are used only once, although a flake that is unsuited for one task may later be reused in another' (Parry and Kelly 1987:287).

A review of a number of North American assemblages indicates a shift toward expedient core technology, with the employment of bipolar techniques, from about 500 AD. Mesoamerican assemblages demonstrate the technique far earlier, sometime between 1500-1000 BC (Parry and Kelly 1987:288-293). It is heartening to note that 'Even those industries with the greatest emphasis on expedient core reduction retained at least a few formal tools that were produced by specialists' (Parry and Kelly 1987:296). In all cases Parry and Kelly found a positive correlation between the decrease in formal tool use and the first occupation of large, permanent villages qualitatively different from earlier villages; that is, the shift to expedient core technology is correlated with a shift to sedentism (1987:297). They do point out, however, that expedient tool manufacture may also be performed by highly mobile hunter-gatherers who have access to abundant and widely distributed raw materials (1987:301). In any case, expedient core technology is not costly in terms of time or effort but 'is wasteful of raw material' (Parry and Kelly 1987:303).

In exploring mobility and technology in the Kakadu wetlands, Hiscock (1996:152) disputes Parry and Kelly's assertions that expedient technology is wasteful or that it is unstandardised. Bipolar stoneworking is 'unsurpassed' among percussion techniques in its ability to prolong reduction and remove more material from a core especially in situations of low inertia (cores too small for working by other percussion techniques) (Hiscock 1996:152). Bipolar knapping may often appear towards the end of a reduction sequence; it is useful in situations where raw materials are not immediately available, or when scavenging of previously discarded artefacts is a means of limiting raw material importation (Hiscock 1996:52). Examination of the frequency of bipolar cores may identify differences in residential mobility within or between regions (Hiscock 1996:152-3).

Hiscock found that there was a difference in the frequency of bipolar cores between woodland and floodplain sites along the South Alligator River. Woodland sites had relatively low numbers of bipolar cores, although their proportion increased away from raw material sources. Hiscock interpreted this as an attempt to ration raw materials rather than return to the source to obtain further supplies (1996:153). The floodplain sites on the other hand had far higher proportions of bipolar cores even if the site was on or near a source of knappable rock. There was no noticeable correlation between bipolar frequency and distance from rock outcrops; every core that could be worked using a bipolar technique had been worked that way (Hiscock 1996:154). He determined that the floodplain sites indicated low residential mobility (with intensive occupation), while the woodland sites (with the relatively low frequency of bipolar cores) indicated a relatively high level of residential mobility (Hiscock 1996: 154). It should be noted that 'residential mobility' in this context is not the same as Lurie's or Binford's definition of residential mobility, but instead refers to levels of residential movement between highly mobile and sedentary (see Hiscock and Clarkson 2000:102).

Distance-decay, rationing, and raw material availability

Byrne's 1980 paper on the dispersal of silcrete in many ways set the tone for subsequent Australian studies concerned with raw material distance-decay and distance to source models. It has certainly influenced the present study. As such it is reviewed in some detail, and then followed by brief reviews of two other Australian studies. Two overseas case studies are also briefly reviewed.

Following observations made in ethnographic studies such as those by Hayden and Gould, Byrne (1980) looked at archaeological sites around a silcrete quarry near the Murchison River in Western Australia and the effect of distance from the quarry on stone tool assemblages (Byrne 1980:110). Forty-five sites were recorded, with silcrete present at 41. Byrne noted that the incidence of silcrete was related to the distance from the quarry; the effect of this 'relative distance' variable became a focus of the study (Byrne 1980:110).

As the 'agencies of dispersion' of the silcrete were mobile individuals and /or groups of Aborigines, the sites and assemblages reflect a behavioural system. The assemblages are spread over a distance of 27 km from the quarry, so Byrne was able to sample the dispersion process over a radius of 27 km and establish a flow of the stone resource through the culture system (1980:111). Byrne cites the Schiffer (1972) model in breaking the flow process down into more or less discrete stages of procurement, manufacture, use, maintenance and discard, all of which have temporal and spatial dimensions (Byrne 1980:112). Because of the generally undateable nature of surface sites, Byrne addressed the spatial dimension.

Byrne concentrated on the relative linear distance from the raw material source with a working hypothesis that supply diminishes with increasing distance from the source. Two questions arose from the hypothesis; how diminishing supply would be registered at particular sites, and what behavioural responses were made in terms of treatment of the stone (Byrne 1980:112). Byrne was reasonably certain that the Pillawarra quarry at the centre of the survey area was the source of the silcrete assemblages (1980:113). As he was testing the dispersal of a raw material rather than 'finished' tools, the

> analysis of the flaked stone material attempted to be all-inclusive: primary flakes and cores were included with the retouched items...As far as I can tell I am not dealing with dispersions of 'finished' tools from a factory site, but with a raw material which appears to have left the quarry in the form of cores and primary flakes as well as, perhaps, 'finished' items...given ethnographic evidence of significance of unretouched items as implements...it seems unwise to make a dichotomy between worked and unworked material, and better to think in terms of a continuum of increasing modification of stone material depending upon such variables as the intended function and the duration of use of the implements (Byrne 1980:113).

The assemblages were ordered into three concentric zones chosen to correspond to a tendency for the sites to cluster into three concentric bands. The sites within each zone were combined into three agglomerate assemblages to overcome the problem of the range in assemblage sizes (from 1 to 904 artefacts). The distance intervals were Zone I, 0-2.5km; Zone II, 2.5 - 10km; and Zone III, 10-27km. Only silcrete artefacts were included in the analysis. Chert and quartz artefacts also occurred in the assemblages; there were many possible sources of chert in the Murchison River valley, and quartz pebbles were relatively common in the riverbed (Byrne 1980:112-113).

Byrne found that silcrete cores had almost dropped out of the archaeological record by Zone III, with only eight found from amongst 25 assemblages (Zone I had 197 cores from four assemblages, and Zone II 103 cores from nine assemblages). Similarly the mean weight of the cores dropped significantly away from the quarry. The results for flakes reflected those of the cores, except that the mean weight of unretouched flakes in Zone III was slightly higher than those in Zone II (4.1gm as opposed to 3.4gm) (Byrne 1980:114). Byrne does not comment on whether this result is significant. However he does note the tendency of the small size classes of flakes (≤4cm) to become proportionally more important over distance while the large size classes (>4cm) become less so (1980:114). There was a trend for retouched flakes to occur more frequently as the distance increased. By Zone III, over 18% of the flakes exhibited retouch. Byrne says this trend was also demonstrated in 'tool' cores (which exhibit retouch on cutting edges and/or edgewear) but I am unconvinced by the definitions and data presented (Byrne 1980:115-116).

The frequency of raw materials also changed as the distance from the silcrete quarry increased. At the quarry silcrete accounted for almost 100% of the raw material, with a very small quartz component present. In Zone I, silcrete accounted for 90% of the raw material with quartz and chert each accounting for about 5%. In Zone II, just over 60% of the artefacts are silcrete, with about 35% chert and 5% quartz. By Zone III, chert accounts for about 45% of the artefacts followed by silcrete (about 35%), and with about 20% of the artefacts quartz (Byrne 1980:114, 116).

Overall Byrne demonstrated that silcrete cores and flakes diminished in size and number as the distance from the quarry increased, while the frequency of retouch increased. He proposed three responses to the diminishing supply of raw materials: that maintenance of the artefacts increased; that there was increased selectivity in the discard of the flaked stone material carried between sites; and that here was increased procurement of alternative raw materials (Byrne 1980:118). While some of Byrne's methods may appear simple or clumsy in retrospect, the study retains its importance in demonstrating the relationship between artefact morphology and distance to source.

Hiscock's study of assemblages from Lawn Hill Station in north-west Queensland also demonstrated that distance from quarries or raw materials sources was a major determinant of assemblage composition. Although artefacts were found throughout the 770km^2 study region, sources of stone suitable for artefact manufacture were few and restricted to areas to the north and south (Hiscock 1988:43, 95). It is not possible here to review Hiscock's results in their entirety so I will briefly summarise results from the main northeast-southwest transect, run between greywacke outcrops in the north and chert outcrops in the south (Hiscock 1988:103). With increasing distance from the raw material sources:

- the percentage of each raw material decreases;
- flake and core size decrease;.
- frequency of platform preparation increases;
- the percentage of retouched chert flakes increases (the number of retouched greywacke flakes was too small for a comparable calculation);
- the percentage of flakes with edge damage increases;

- core rotation increases;
- the amount of cortex on flakes decreases;
- cortical platforms on greywacke flakes decrease; and
- cortical platforms on chert flakes increase, possibly as the result of core rotation and/or the selective transportation of flakes with cortical platforms (Hiscock 1988:105-108).

'At Lawn Hill it was not artefact function that determined artefact form, but the economics of stone procurement and knapping' (Hiscock 1988:114). Hiscock considers that technology at Lawn Hill is not embedded in subsistence patterns but that curation of artefacts is a response to shortages of raw materials rather than to time stress or food procurement strategies (Hiscock 1988:i, 307-311; cf Bamforth 1986). Food resources were abundantly available along Lawn Hill Creek, and the only economic reason for regular north-south or south-north movement was for procurement of knappable stone. Social and exchange links with neighbouring groups may also have provided reasons for such movements (Hiscock 1988:312).

At Cooloola in coastal southeast Queensland, McNiven used unbroken, unmodified flakes to investigate raw material rationing as distances from sources increased. McNiven chose unmodified flakes as they occur at all stages of artefact reduction and 'therefore provide a more complete insight into the range of technological activities occurring at sites' (McNiven 1990:327).

The three main raw materials used for artefact manufacture at Cooloola were andesite, arkose and silcrete. Andesite occurs as dykes at Double Island Point at the northern end of the study area; arkose outcrops in low hills at the southern end of Teewah Beach; and silcrete occurs west at Wolvi Mountain and Mount Condoo, between 20-25km from the coast. Andesite flakes were restricted to the area closest to Double Island Point, with a single flake found about 20km south of the source. The relative proportion of andesite flakes also decreased consistently as the distance from Double Island Point increased, as did the size of the flakes. In the case of arkose, flakes extended along most of the length of Teewah Beach but were most concentrated on the southern end. The proportion of arkose flakes decreased northwards with increasing distance from the source. Silcrete flakes were found along most of Teewah Beach, with their relative proportion decreasing with increased distance from the probable sources. While this is evidence of the transport of silcrete throughout the region, andesite flakes dominate the assemblages close to Double Island Point. Although inferior to silcrete as a raw material, its proximity was more influential in exploitation than its quality (McNiven 1990:332-33).

Like Hiscock, McNiven found that raw material procurement was not embedded in basic subsistence schedules. The proportional decrease in raw material use as distance from replacement stone increases demonstrates that the Cooloola residents associated energetic costs with the procurement of stone. There was also no apparent association between raw material use and the amount of subsistence activity at sites, indicating some independence between technological and subsistence activities (McNiven 1990:340).

In their study of Late Prehistoric Rockport-phase lithic technology from the central Texas Coast, Ricklis and Cox found the

> 'spatial structure of lithic technology was the product of a logistical pattern of procurement and transport of raw material that was not correlated to the residential mobility patterns inherent in subsistence. These two cultural subsystems were organised to definably different principles - lithic technology was based on a strategy that compensated for increasing technological inefficiency in order that

more fundamental requirements of biotic-resource procurement could be fulfilled' (Ricklis and Cox 1993:445).

Ricklis and Cox examined artefacts from sites designated 'Group 1'(large autumn/winter fishing and shellfish gathering sites on the shoreline) and 'Group 2' (relatively smaller spring/summer hunting and gathering sites on coastal prairie uplands). The study area had only one source of usable chert, located in the uplands, so the distance from source to site could be accurately defined (Ricklis and Cox 1993:445, 447). Four flake categories were employed in the analysis: primary (dorsal surface 100 % cortex); secondary (some dorsal cortex); tertiary (no cortex except occasionally on the platform); and biface thinning flakes (late-stage tertiary flakes) (Ricklis and Cox 1993:452).

The results showed that except for a general trend in the increase of biface thinning flakes, there was no significant change in reduction activities as distance from the chert source increased. There was no difference in the reduction sequences between the Group 1 and Group 2 sites. Primary, secondary and tertiary flakes were present at all sites, indicating that the complete reduction sequence took place despite an increasing relative cost of raw material. Bifacial thinning flakes suggest an increase in biface rejuvenation as raw material cost increased (Ricklis and Cox 1993:452). As distance from the source area increased, so did the percentage of flakes exhibiting edgewear. At the chert source less than one percent of flakes showed signs of use, at the most distant site (70km) over 60% of the flakes were utilised. The average length of the flakes decreased by about 1cm in the first 20km away from the source area but then remained fairly consistent. Arrow points, on the other hand, became smaller as distance increased. The researchers concluded that unworked cobbles of uniform average size were transported to all sites for use as cores; this is reflected in the uniform average length of flakes. The cores closer to the source area were larger, as evidenced by the greater average flake length. The decline in the length of the arrow points was due to resharpening and/or the use of smaller flakes for manufacture (Ricklis and Cox 1993:454-455).

Close's work on Neolithic sites the Safsaf sandsheet in the eastern Sahara is particularly interesting from the point of view that the area has no rock outcrops so all raw materials had to be brought in (Close 1996:545). She mapped and collected artefacts from an area of 15km^2, unused since occupation ceased c5500BP, which had probably been a source of grasses and seeds for pastoralist groups (Close 1996:550). In refitting the artefacts Close identified two distinct technological systems. The first was of large blades and flakes ('isolates') that were brought in already struck and mostly unretouched, although some retouching in the form of resharpening subsequently took place. The second system consisted of cores brought in, in anticipation of the need for fresh unretouched flakes. These flakes are smaller than the pre-manufactured flakes and almost never retouched. Short but completely refitted sequences strongly indicate that they were struck as needed for some immediate purpose (Close 1996:549). The overall picture is one of small and highly mobile task groups moving short distances across an area which contained a desired resource (grass or seeds) but which did not contain a needed resource (stone). Close argues that large pieces of stone (some 30cm across and weighing up to 40kg) were stockpiled for use as cores, and that cattle may have occasionally been used as a means of transport for the larger cores. The isolates could have sustained damage if transported on a cow's back, even if wrapped or separately bagged, along with the larger cores. One person could, however, have easily carried in several isolates (Close 1996:550-551) (and smaller cores).

On the basis of the refitting evidence, Close determined that people were not 'striding purposefully' from one end of the sandsheet to the other but moved more circuitously, albeit over straight-line distances of less than 6km. This was too short for a distance-decay model to be markedly evident; while the stone sources were more than 20km from the southern end of the sandsheet the possible use of cattle as pack animals also compromised such a model (Close 1996:551).

The Safsaf artefacts are simple as befits the exploitation of low risk resources but they were curated and in the case of retouched tools resharpened. Close considered them to display a mix of Binfordian logistical and residential mobility features (1996:551). 'Having tools suitable for the job at hand was evidently a more important consideration than the mere difficulties of getting them there' (Close 1996:552).

Summary

In this chapter I reviewed some of the literature relevant to understanding the Bribie Island assemblage. The literature demonstrates that although the concept of a purely technological analysis is in itself quite straightforward, its application is much less so. The history and study of stone artefact analysis almost inevitably leads to inculcation of function, morphology and style based on 'recognised' tool types and a distinction between artefacts that are simply flaked and those that are further modified by retouch. Retouched artefacts are commonly designated 'tools', while unretouched artefacts are either 'blanks', 'preforms', or 'debitage' although their use as 'tools' is ethnographically documented. Interpretations of tool/non-tool are still made based on morphology and technological attributes regardless of evidence of use (although studies by Hayden and Gould suggest that evidence of usewear may be misleading). Despite technological analyses having been employed for many years, definitions may still be ambiguous and variable. Definitions of mobility also abound, and clearly mean different things to different researchers. Discrepancies, contradictions and apparent inconsistencies all seem to co-exist within the literature surrounding the study of stone artefacts. It is indeed possible that no ultimately 'definitive' definitions will ever be agreed upon. Perhaps the ideal should forever remain elusive, to reflect the diversity of human behaviour. The literature discussed above, however, demonstrates that despite this lack of agreement, application of technological analyses to questions of spatial variation and settlement character is a valid and valuable technique.

This chapter has provided the literary and theoretical context for the study; the next chapter establishes its environmental context.

CHAPTER THREE ENVIRONMENTAL CONTEXT

In this chapter I describe the environmental context of the study area. I include an overview of the physical environment, as well as discussions of the vegetation, fauna, geomorphology and hydrology of Bribie Island. Hall highlighted the need for a regionally specific environmental history - geomorphology, palaeogeography, palaeoclimatology and palaeoecology - linked to the Aboriginal past (1999:180). While my research does not fall into the 'palaeo' category, the 'face' of Bribie Island has certainly changed considerably over the last 100 years or so.

Physical environment - overview

Bribie Island is the northernmost island of Moreton Bay. It is separated from the mainland on the north and west by Pumicestone Passage, a narrow tidal estuary c500m - 3km wide, and is bounded by Moreton and Deception Bays in the south. The eastern coast directly faces the Pacific Ocean (see Figure 1.2). The Island is 32km long and between 5-8km wide, with an area of approximately 143km^2. Much of the Island lies at or below 5m in elevation, but some areas reach elevations of up to 14m. The Island is largely formed of remnant Pleistocene aeolian sand dunes, which run roughly north-south. The southernmost area of the Island consists of Holocene dunes which run east-west (Willmott and Stevens 1988). In east-west cross section the terrain exhibits low peaks and swales.

The Island has a large central swamp or swale, fed in part by Westaway Creek, which runs in from Pumicestone Passage in the north-west. High groundwater levels (see Harbison and Cox 1998) also maintain this swamp. There are lagoons behind the foredunes on the east and south-west coasts of the Island, and five freshwater creeks have been identified. Pools and small swamps of low salinity (Batianoff and Elsol 1989) are present in almost all low-lying areas.

The surf beach and dunes on the eastern coast of Bribie Island are subject to continuing erosion. Despite periodic surveys by the Coastal Protection Authority, there are no statistics available on erosion rates. Development on the east coast is limited to areas that are at least 140m from the high tide mark (Coastal Protection Authority verbal advice). Examples of the severity or extent of erosion are evidenced by the WWII gun emplacements at Fort Bribie in the Island's northeast. These were constructed behind the foredune in 1942; at least one is now located on the beach itself (Batianoff and Elsol 1989:3; P.Waterson, pers. comm. 1999). During the 20th century the surf club building at Woorim on the southeast coast was moved further inland three times because of beach erosion. Batianoff and Elsol suggest that erosion in this area is the result of shoreline recession due to changing sea level. Sea levels have risen on average 10cm over the past 100 years due to thermal expansion of oceanic upper layers and increasing atmospheric carbon dioxide levels. These may accelerate coastline recession, intensify erosion, and cause structural damage and marine flooding during storm surges, resulting in a rise in coastal water tables (Batianoff and Elsol 1989:1). Other causes of beach and dune erosion include wave action, cyclones, storms, and four-wheel drive vehicle activity.

Erosion has undoubtedly impacted on the archaeological record along the east coast. With the exception of BI04 (a single artefact site), no sites have been recorded close to the present east coast. This does not imply that no sites are or were located there (ethnohistorical information suggests the opposite; see Chapter Four), but rather that post depositional taphonomic and morphological action has destroyed or covered the sites.

Even less information is available concerning erosion rates of the west coast facing Pumicestone Passage. Although tidal, the waters of Pumicestone Passage are low energy and erosion is likely to be less severe and rapid than on the high-energy east coast. A source of erosion on the west coast is boat wash from the hundreds of pleasure and fishing craft which use Pumicestone Passage; certainly the changing sea levels posited by Batianoff and Elsol (1989) for the east coast of the Island must also be implicated in west coast erosion. My observations on the coastline adjacent to the White Patch area over the past 12 years suggest that the dune ridge abutting the shore has receded by up to one metre. Comparison of aerial photographs taken in 1958 and 1967 of the northernmost tip of Bribie Island show that land covered by stable scrub vegetation disappeared over these nine years, changing the shape of the area from club-like to more pointed. The land lost was mainly in Pumicestone Passage (Batianoff and Elsol 1989:33). No archaeological sites have been located along this northern peninsula of the Island, despite its close proximity to the present mainland. The changes observed between 1958-1967 may help to explain this absence.

Vegetation

Bribie Island is typical of the coastal lowlands or 'wallum' country characterised by Coaldrake (1961:5) as low undulating areas below the 30m contour, all of which have an assured rainfall, similar soil morphology, low soil fertility and similarly constructed floristic communities. The floristic communities form a dynamic mosaic of dry scelorophyll open forests, heaths, sedgelands, dunes, swamps, lakes, streams and mangrove communities. The Bribie Island mosaic has been significantly altered by residential development on the southern one-third of the Island, and the planting of approximately 4000ha of exotic slash pine (*Pinus elliotti*) in the northern half of the Island between 1959 and 1972.

McDonald and Elsol (1979) identified and mapped the pre-plantation vegetation of Bribie Island using pre-1958 aerial photographs. In all, eight vegetation units closely related to differences in elevation were identified and described:

1. Littoral vegetation (including mangroves, saltmarsh, closed grassland, mudflats and swamp she-oak open forest);
2. *Melaleuca quinquenervia* (broad-leaved paperbark) open forest;
3. *Eucalyptus tereticornis*, *M. quinquenervia* and *Tristania suaveolons* (forest redgum, broad-leaved paperbark, and watergum) open forest;
4. *Eucalyptus intermedia*, *Callitris columellaris* and *Banksia* spp. (pink bloodwood, Bribie Island cypress, and banksia) open forest;
5. *Eucalyptus signata* and *E. intermedia* (scribbly gum and pink bloodwood) open forest and woodland;
6. *M. quinquenervia* woodland and low woodland;
7. *Banksia aemula* (wallum banksia) low woodland;
8. Open heath and sedgeland. (McDonald and Elsol 1979:49-53).

The list of species is certainly not exhaustive and many others are also observed in the field.

I modified McDonald and Elsol's vegetation map based on observations made during my 1992 Honours fieldwork (Figure3.1). McDonald and Elsol seem to downplay the presence of the fern *Blechnum indicum* (bungwall) in their descriptions, perhaps because of their reliance on aerial photographs. From personal observation, this plant is ubiquitous in its association with low-lying and swampy areas, and is especially vigorous in open locations. It is often associated with *Melaleuca* (Figure 3.2). Batianoff and Elsol have described the vegetation of Bribie Island in detail; they mention *B. indicum* as one of the common herbaceous species within the heathland-herbland vegetation widespread between Teewah and Bribie Island (1989:84). *B. indicum* often occurs in exposed areas, and does not grow well in complete shade (Cronin 2000:136) (Figure 3.3). Ethnohistoric and archaeological data suggest that this plant was a starch staple of the people who lived on Bribie Island (see Chapter Four).

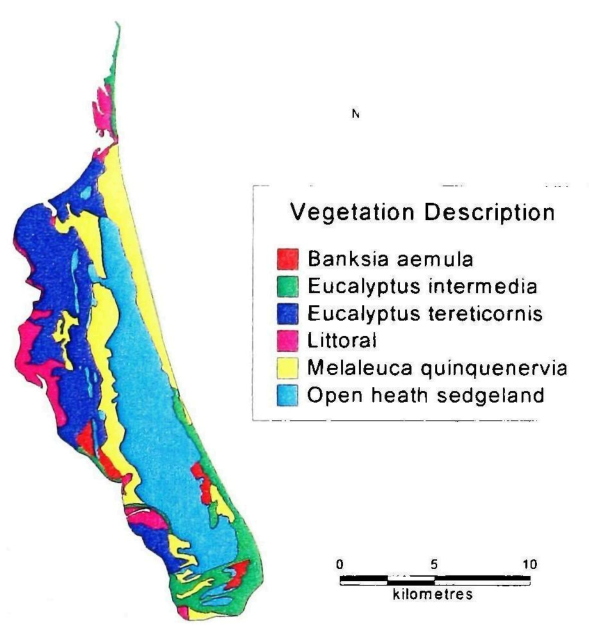

Figure 3.1 Vegetation map of Bribie Island

In my research I have documented numerous additional floristic communities. For example, during surveys in 1994 for the previous leaseholder, Emmanuel Pty Ltd., I met commercial florists in the pine forest who were collecting the herbaceous species *Restio pallens* and spikes from the grass tree *Xanthorrea fulva* for export purposes. The giant or blue waterlily *Nymphaea gigantea* is found in ponds on the Island; also present in the southernmost area of the barrier swamp are cabbage tree palms (*Livistona australis*).

Figure 3.2 *Blechnum indicum* associated with *Melaleuca*, Bribie Island central swamp (Photo: T. Smith).

Figure 3.3 *Blechnum indicum* in open low elevation, Bribie Island (Photo: T. Smith)

Most of these plants are recorded as being used by Aboriginal people. The heart of cabbage tree palms provided vegetable food, while the gum was chewed as a sweet; and the leaf shoots were made into fibres (Symons and Symons 1994:78). The various parts of *Xanthorrea* were used for making sweet drinks and flour, for firemaking purposes, and as a source of resin in glues for waterproofing bags as well as fixing axe heads and spear points. It was also a trade item (Symons and Symons 1994:95). Almost all of the *Nymphaea* was utilised: the seeds were eaten raw, or pounded and baked; the roots were roasted and eaten; and the leaf stems eaten raw as a vegetable or used as straws in scummy water (Symons and Symons 1994:83). A complete review of Aboriginal use of plant resources is not possible here, but most of the plant species found on Bribie Island played some part in the Aboriginal economy as food, medicines or raw materials.

The commercial pine plantation covers much of the area of former heath and sedgeland, as well as former open forest areas, mainly along the relic Pleistocene dune ridges and slopes. The ridges and slopes are also the locations of many of the archaeological sites, having provided a desirable combination of elevation away from swamps and insects, possible vantage points, and shaded dry, campsites (see Jochim 1976; McNiven 1984; Smith 1992). Clearance of the native vegetation prior to the planting of the exotic pines was achieved by chaining using pairs of D7 Caterpillar Tractors (Mr B. Youngblutt, former APM foreman, pers. comm., 1991). Usually the felled vegetation was pushed into windrows, but occasionally larger trees were left where they fell if they did not interfere with the planting operation. One such example, probably a forest redgum (*Eucalyptus tereticornis*), was found at BI74 on the main western ridge, in an area of former open forest (Figure 3.4). Harvesting of the pine plantation commenced during

Figure 3.4 Fallen *Eucalyptus tereticornis* at site BI74 (Photo: T. Smith)

Figure 3.5 Recolonising native species at site BI18 (Photo: T. Smith)

the present fieldwork and native species have been observed vigorously recolonising the cleared blocks (Figure 3.5). The National Park, which fringes all but the southern boundary of the pine plantation, has in many areas heavy undergrowth not only of native species but also of introduced lantana and other noxious species; in places this undergrowth is virtually impenetrable. Due to funding and personnel constraints, and management strategies, these areas are not burned off or otherwise cleared.

The density of the pine plantation, and the height of the trees, had obscured the topography of the Island. No landmarks or important cultural landscape features were visible from within it. Once the harvesting was well advanced one could see from the higher elevations the Glasshouse Mountains (Figure 3.6), important landscape features in the Dreaming of the region (Ms. Vicki Turner, pers. comm., 1991).

Figure 3.6 The Glasshouse Mountains from site BI30 (Photograph: T. Smith).

The distribution of vegetation types is related to soil water availability and nutrient status, salinity and waterlogging tolerance, landform ages (Harbison and Cox 1998:116) and also elevation. These are important considerations in explicating patterns of Aboriginal settlement and use of the Island. I infer from the environmental, ethnohistorical and archaeological data that the vegetation of Bribie Island during Aboriginal occupation was more open than has previously been considered. Although McDonald and Elsol (1979) mapped the pre-plantation vegetation using pre-1958 aerial photographs, these photographs were taken more than 80 years after traditional Aboriginal occupation and use of the Island ceased (see Chapter Four). Direct ethnohistorical evidence is lacking, but it is reasonable to infer that, in common with other groups in the Moreton Region, the Aboriginal occupants of Bribie Island managed their environment by various means including the use of fire. The presence of banksia species that require firing to set seed (with the exception of *B. integrifolia*) supports this inference. Traditional management processes would have kept forested areas reasonably open. I also believe that wetland areas were more extensive during the pre-European era than presently (see Hydrology and Summary below).

Fauna

I have detailed the faunal and avifaunal species present on Bribie Island and in Pumicestone Passage elsewhere (Smith 1992:17-21). The native terrestrial fauna reflects the typically depauperate fauna of wallum country (Coaldrake 1961). The list of mammals includes eastern grey kangaroo, swamp wallaby, brush-tailed and common ringtail possums, echidna, planigale, dingo, two species of melomys, and three species of rat. Introduced species include the domestic cat, cane toad and the house mouse

(Barry 1984). All of the native species except dingo are recorded as Aboriginal food sources.

Much of the central-western area of the Island was under grazing lease until the 1950s-1960s. Although most of the stock was removed from the Island, fresh traces of cattle can be found around the old yards at Poverty Creek. As part of the National Parks programme to rid the Parks of introduced species, the Turnbull family who previously held the grazing lease have trapped and removed most of the remaining cattle. Those that cannot be trapped were to be shot from helicopters (Queensland Parks and Wildlife Service [QPWS], verbal advice 1999). Feral pigs are also present on the Island; their diggings can be found at numerous sites in the pine forest. They are particularly active in the northern part of the Island, and their rooting and tracks are commonly observed (see Figure 3.7). Approximately 60 were removed from the Island in 1999 (Mr C. Morris, CSR, pers. comm., 1999). In the north-western area of the Island there are also traces of horses. Although no animals have actually been sighted by QPWS Rangers, CSR/Sunchip crews, or by me there are numerous large piles of dung such as those deposited by stallions marking their territory. Dr Anne Ross of the University of Queensland School of Social Science reported seeing six or seven horses at Poverty Creek in the early 1990s (pers. comm.1999). The presence of all of these introduced animals belies the statements by Welsby, Meston, and others that Bribie Island was of no grazing value. My inclusion of a discussion of these herbivores, ruminants, and omnivores among the fauna of Bribie Island is for the purpose both of exhibiting the potential for grazing species to flourish on the Island (including macropods); land and vegetation types; and also to highlight some of the post depositional sources of disturbance of the archaeological record.

Figure 3.7 Feral pig damage at site BI09 (Photograph: T. Smith).

Herptile species recorded for the Island include 10 species of frog, one species of turtle (common long-necked turtle), two species of flap-footed (legless) lizard, one species of dragon, two species of monitor (goanna), and seven species of skink (Barry 1984; Smith 1992). Barry (1984) recorded four species of snake – carpet python, green tree snake, keelback and marsh snake – however, red-bellied black snakes have also been observed on the northern swamp margins (M. Carfoot, CSR, pers. comm. 1999). Other than the red-bellied black snake, all herptile species are suitable for or have been recorded as fit for consumption.

Bribie Island and Pumicestone Passage support a rich avifauna. These include black duck, grey teal, chestnut teal, black swan, white ibis, strawnecked ibis, and pelican. Other species noted include herons, egrets, curlews, dotterels, godwits, whimbrel and, occasionally, brolga (Sattler 1979:116). Raptors include wedge-tailed eagles, osprey, nankeen kestrel and kites; I have also observed several of the generally uncommon little eagle. Various species of honeyeaters are present, as are kingfishers, warblers, whistlers, rainbow and scaly-breasted lorikeets, and little wattlebirds (Sattler 1984:116-117). I have observed a variety of pigeon species, notably the common bronzewing. There are also at least three breeding groups of emu currently resident on the Island. Generally a paucity of bird species is found among the pines; they are most common in the remnant native vegetation within the pine plantation, areas of recolonised native vegetation, and the National Park.

Pumicestone Passage and the oceanic coast of Bribie Island support a large variety of fish, including bream, mullet, several species of whiting, jewfish, tailor, luderick, tarwhine, mangrove jack, threadfin salmon and flathead (Harrison 2002; Thompson 1975). Although some of the species peak at certain times of the year (e.g. mullet 'runs' in April-June) the variety of species ensured a year-round staple resource for the people of Bribie Island and the greater Moreton Region (see Nolan 1986; Walters 1987). The Passage is a nursery for eastern king prawns (*Penaeus plebejus*), brown tiger prawns (*P. esculentus*), banana prawns (*P. merguiensis*) and endeavour prawns (*Metapenaeus endeavouri*). It is also the home of bay prawns (*M. benettae*), which were commercially netted in the Passage until 1998 when the practice was banned because of detrimental environmental effects. Although there is no direct evidence from the archaeological record, it is a reasonable inference that these species were also a food source for the Bribie Island and Moreton Region Aborigines.

Mud crabs (*Scylla serrata*), sand crabs (*Portunus pelagicus*) and a variety of smaller species also inhabit the Passage. Dugongs (*Dugong dugon*) were once reasonably common in Pumicestone Passage (see Welsby in Thomson 1967). Dugong distribution is closely tied to seagrass distribution but there is now relatively little use of the seagrass beds in Pumicestone Passage, apparently as the result of higher levels of boat traffic (Preen 1995:314). Green turtles (*Chelonia mydas*) are still relatively common in Pumicestone Passage (Limpus 1995:169) but are also victims of boat traffic; over the past 12 years I have found a number of corpses washed ashore near White Patch.

The extensive mudflats and mangroves of Pumicestone Passage as well as the ocean sands support a diverse and rich shellfish population. The most common species are oyster (*Saccostrea glomerata, S. cucullata*), cockle (*Anadara trapezia, A. granosa*), mudwhelks (*Pyrazus ebeninus*, *Velacumantus australis*), pipi or eugarie (*Donax deltoides*), hairy mussel (*Trichomya hirsuta*) and snail (*Polynices sordidus*, *P. conicus*). These species are among those most prominent in the archaeological record.

Geomorphology

Moreton Bay reached its present elevation about 6000 years ago when sea levels stabilised after the last marine transgression (Flood 1981, 1984; Hekel *et al.* 1979; Willmott and Stevens 1988). Bribie Island existed at that time, although with a slightly different shoreline from today. The present curvature and shoreline position of the Island are in part due to its protection by Moreton Island and a large complex of submarine sand banks and channels several kilometres offshore (Batianoff and Elsol 1989:32).

Bribie Island is essentially a large sandmass formed of remnant Pleistocene beach dune ridges; Quaternary sandplains, estuarine, flood and/or tidal deposits; and Holocene beach ridges. In cross section the Island exhibits a series of low peaks and swales. The Pleistocene dunes form beach ridge plains running mostly parallel to the present coastline (Batianoff and Elsol 1989:27), and represent one the few surficial exposures of Last Interglacial sediments in Moreton Bay (Cotter 1995). The Holocene ridges are generally narrower, more sharply crested and closely spaced than the broader, more widely spaced Pleistocene ridges which are usually of higher elevation (Hekel 1978). The southern Holocene beach ridges are roughly transverse, and represent a progradation of approximately two kilometres over the last 4500 – 6000 years (Coaldrake 1961; Flood 1984; Hekel *et al.* 1979; Willmott and Stevens 1988:16-17). The change in direction may be due to changes in the direction of prevailing waves in the northern parts of Moreton Bay (Batianoff and Elsol 1989:27). The northern Holocene dune ridges are most likely aeolian; the result of prevailing south-easterly winds (Batianoff and Elsol 1989). The soils are siliceous podzols and humus podzols (or intergrades between the two) with very low fertility and salinity levels (McDonald 1983 in Batianoff and Elsol 1989). In the western section of the Island there are clayey sands associated with the lowering of the sea level, and incised by Pumicestone Passage (Harbison and Cox 1998:116). The sandy soils overlie discontinuous layers of kaolinite mud, deposited in low energy bay and lagoonal environments (Hekel and Day 1976, Ishaq 1980 in Armstrong and Cox 2002:n.p.) or red-grey mottled clay which is probably weathered sandstone (Harbison and Cox 1998:116). These mud/clay levels are absent from bores drilled at White Patch and Woorim, and the Pleistocene sediments directly overlie the basement rock of decomposed Upper Triassic-Lower Jurassic Landsborough Sandstone (Harbison and Cox 1998:116; Armstrong and Cox 2002:n.p.). The sand profile is 40m deep on the central east coast of the Island, with the shallowest profile at 5m in the north-west of the Island where Pumicestone Passage is also at its shallowest (Harbison and Cox 1998:116). Study of the literature has revealed no description of the soils from the north-western area of the Island formed on sandplains, estuarine, flood and/or tidal deposits. However, based on observation the soil is likely to be a humus podzol with a high organic content.

Contained within the Pleistocene sediments and with a maximum measured thickness of 9m in the southern part of the Island, is coffee rock (also known as beach rock) which forms in coastal areas. Patches of coffee rock are exposed on the central and northern shores of the west coast, and on the southernmost coast of the Island. It is the only 'rock' occurring naturally on Bribie Island. While referred to in common parlance and in a number of studies as 'rock' (the definition of which it very loosely fits), coffee rock is essentially a very soft material unsuitable for knapping. Its presence is more valuable in explaining the geomorphology of the Island. Coffee rock is essentially a humicrete composed of quartz sand grains cemented by clays and organic material. The level of induration is indicative of seawater intrusion (M. Cotter, email received 22 April 1999; Harbison and Cox 1998:123). Its widespread presence on Bribie is indicative of the extent of podzol soils on the Island, and the stripping of upper horizons by wave action and beach erosion (Dr Annie Ross, pers. comm., 2003).

Flood (1981) proposed a late Holocene coastal evolution model for the Deception Bay area. The sequence of events was that the sea level was at or above its present level about 6000 years ago, 0.7m higher than present at 4700 years ago, and 0.4m higher than present at 3300 years ago (in Cotter 1995). Uranium series dating, palaeobotanical evidence and geochemical evidence to support Flood's sequence have been found in the vicinity of Bribie Island, coincidentally providing information on mid-late Holocene changes on the Island itself. These changes have implications for the identifiable patterns of Aboriginal settlement of the Island, especially on the coastal fringes.

Uranium series dating of fringing coral reefs from the northern tip of Bribie Island indicate a date of 6300± 500 BP. This date suggests that the sea level was at or near its present level at that time (Flood 1984:127). Cotter derived evidence for a higher mid-Holocene sea level from palaeobotanical data from two test pits excavated at Bribie Industrial Sands as part of sand extraction operations near Beachmere on the mainland contiguous to Bribie Island (1995:6). Two genera of mangrove pollen were identified, *Avicennia* (grey or white mangrove) and *Aegiceras* (river mangrove). As these types of mangrove presently co-exist within Pumicestone Passage, Cotter proposed that similar climatic and hydrological conditions to those of the present prevailed in the vicinity at the time of deposition (1995:6-7). The reduced levels at the top of the excavation pits indicated that the sea level would need to be at least 1m higher than present to allow deposition of the pollen at 30cm below the present ground surface. Accelerator Mass Spectrometry dating of organic material from one of the pits produced an age of 5800+/-50 years at a depth of 1.14m. Dating of material at 1.04m produced an age of 4610+/-50 years, placing the higher sea level within Flood's time frame (Cotter 1995:7).

Evidence for a higher sea level also comes from reports of acid trending soils within the vicinity of the Bribie Island Industrial Sands extraction centre at Beachmere (Cotter 1994; Sutherland and Amaral 1994 in Cotter 1995). Acid sulphate soils occur when sediments containing sufficient iron pyrite (Fe_2S) in aerobic conditions oxidise to form sulphuric acid. Ultimately the oxidised pyritic soil becomes too acid ($pH<3.5$) for the buffering capacity of the sediments (e.g. alkaline clays or shell materials) to neutralise it (Dent and Pons 1993; Melville *et al.* 1993 in Cotter 1995:7). Pyrite accumulation is the initial requirement for acid sulphate soil formation; therefore *potential acid soils* are those which contain pyrite (Naylor 1993 in Cotter 1995:7). If the soils remain in a waterlogged anaerobic environment, acid generation does not occur. If the pyrite is exposed to air (by drainage or excavation), it oxidises, sulphuric acid is generated, and *actual acid soils* are produced (Naylor in Cotter 1995:7).

Iron pyrite accumulation in soil is dictated by a bacteria-catalysed set of reactions. The reactions are dependent on sufficient ferric iron (contained in most sediments), a (critical) supply of sulphur ions, adequate organic material and a generally anaerobic environment. Because of the enrichment of seawater with SO_4^{2}- ions, coastal environments are primary sites for pyrite accumulation; most favourable are tidally inundated mudflats supporting mangrove communities. Mangroves put large amounts of organic detritus in generally anaerobic muds regularly inundated with sulphur rich seawater (Melville 1993 in Cotter 1995:7). In certain circumstances, brackish water, estuarine and coastal lake environments can also accumulate iron pyrite (Cotter 1995:8).

As the soil samples taken by Cotter at the Bribie Island Industrial Sands site at Beachmere had been exposed to the air, they had possibly undergone recent oxidisation. She considered the data evidence for potential acid soils, but not necessarily actual acid soils. The sediments dated to c6000 years ago contained mangrove pollen, and were situated above the present sea level (i.e. an aerobic environment). Combined with confirmation of *actual* and *potential* acid soils from nearby Beachmere on the mainland (Sutherland and Amaral 1994 in Cotter 1995), it may be concluded that the Bribie Industrial Sands operations have returned pH values reflective of actual acid soils (Cotter 1995:8).

Cotter's findings have implications for the archaeological record of Bribie Island. Acid soils mitigate against the finding of organic material such as shellfish remains or bone, as these would disappear over time in an acidic environment. The pH level of soils associated with excavations at BI09, where the 1992 dates for occupation of Bribie Island were obtained, was 6.5 (MRAP Files). This level is trending towards an acid-neutral soil, perhaps a surprising result in view of the amount of organic material (i.e. shellfish remains) present. The possibility is that the present pH levels are the result of the cumulative effect of deposition of alkaline shellfish remains in an otherwise acidic environment, and are therefore an anthropogenic phenomenon (Dr Anne Ross, University of Queensland School of Social Science, pers. comm., 1999). Elsewhere on the Island recorded pH values vary between 4.5 and 5.5 (MRAP files).

Hydrology

Stockton (1973:50, 1979:100) asserted that Bribie Island has a domed water table. This assumption was based on the water tables of the large nearby sand Islands, Moreton and

North Stradbroke, which have massive dune systems up to 200m in elevation. These Islands, however, are the result of a different sediment deposition history from that of Bribie Island, and there are discernible differences in Bribie's hydrological character (Harbison and Cox 1998:113, 115). Since the relief and hydraulic gradients on Bribie are negligible, the concept of a groundwater mound or dome alone cannot explain the hydrology (Harbison and Cox 1998:123). The groundwater model is in fact quite complex. The most recent studies are based on information from bores maintained by the Department of Natural Resources since the 1980s (recently in association with the Queensland University of Technology). The bores are monitored monthly to assess water levels, water quality, and more recently, to manage clear-felling of pine and regeneration of native vegetation. These models vary in some details while both describing two water bodies. Harbison and Cox (1998:123) argue for a flat water table overlying the coffee rock horizon about 2m above the Australian Height Datum (AHD, or mean sea level, MSL). They also present evidence for a perched water table that closely underlies the topography of the eastern dune system (1998:123). Armstrong and Cox (2002:n.p.) describe two water bodies as a deep partially confined aquifer underlying the leaky coffee rock horizon, and a perched unconfined water table generally following the local topography, commonly at a depth of 1m and with an approximate maximum elevation of 6m AHD. The close proximity of this agreed 'upper' water table to the ground surface means that the groundwater commonly breaches the surface in the swales and low lying depressions between the relic dune ridges and within the minor ridges contained within the larger dune system. Despite the dark colour characteristic of the surface water ('tannin-stained' or 'black water') and shallow groundwater due to a high concentration of dissolved organic material, the free water on the Island is potable (Armstrong and Cox 2002; Batianoff and Elsol 1989; Harbison and Cox 1998). The nature of the water table means that there is a plentiful source of fresh water across the Island, which can easily by accessed by humans, other animals and birds. It is also a determinant of site location.

The average annual rainfall for southern Bribie Island for the period 1977-1996 was 1400mm (Harbison and Cox 1998:115) with most rain typically falling in the summer months. There are no weather stations located on the northern part of the Island, but weather stations immediately to the north and north-west at Caloundra and Beerwah Forest receive approximately 1600mm rainfall per annum. Harbison and Cox presume that the northern part of Bribie Island receives up to 20% more rainfall than the southern areas due to the rain shadow effect on the south of the high outer islands of Moreton and North Stradbroke (Harbison and Cox 1998:115).

Most surface water runoff is from the two major dune systems into the central swale, with runoff also into local low lying depressions. Ponding occurs in low-lying areas where organic silts and clays are deposited after rainfall and settle to form a cap on the surface of the sand reducing infiltration (Armstrong and Cox 2002; Harbison and Cox 1998). The central swale generally has a slow northerly flow, discharging into Pumicestone Passage via Westaway Creek. Some southerly flow also discharges via Wright's Creek (Armstrong and Cox 2002:n.p.).

Two major factors currently influence the drainage system and groundwater-surface water interaction. Increased residential expansion in the southern part of the Island in association with rapidly increased recreational use has meant a recent increase in water extraction from 3ML to 6ML per day, mostly from boreholes located in the southern Holocene dune system (Harbison and Cox 1998:113). Of greater importance in the consideration of Aboriginal use of and movement over the Island is the effect of the commercial pine plantation.

More than 5.2 million pines were planted in the commercial plantation, an average of 1320 trees per hectare (Matt Grant, CSR, pers. comm., 1999). This is a much higher density than would have been the case with the native forest, particularly in the former open forest and heathland-sedgeland, the favoured locations for the commercial plantation. The result is that the massively increased evapotranspiration rate of pine forest affects the groundwater table and discharge rates. Mr Matt Grant of CSR Softwoods advised that pine plantations in other sandy areas of mainland southeast Queensland have altered the water table by up to 1m (pers. comm., 1999). As monitoring of the water table on Bribie Island only began in the 1980s it is impossible to be certain of the pre-plantation levels, however certain inferences may be drawn.

One inference is that the upper, perched water table was even closer to the surface during pre-colonial times than is now the case, and breaches were more common, widespread and permanent. In 1877 Petrie observed 'There is an abundance of fresh water at the place I selected [for an Aboriginal settlement] and in fact on many other parts of the Island' (QSA LAN 5475/77). More direct evidence of the effect of the pine plantation on the water table has been observed in the field since the commencement of harvesting in 1996 (CSR/Sunchip crews, pers.comm.; Armstrong and Cox 2002;

personal observation). Removal of the pines has significantly reduced evapotranspiration rates. The levels of water both in standing bodies and 'soaks' has risen, new waterlogged areas have appeared and the existing areas extended, including the central swale or barrier swamp (Mr M. Grant, Mr C. Morris, CSR, pers. comm., 1999, Armstrong and Cox 2002.n.p.; personal observation). The permanency of the wetland areas has also increased. Hydrographs indicate a considerable rise in the perched unconfined water table although the relationship has not yet been quantified (Armstrong and Cox 2002.n.p.). It is my belief that the surface water patterns observed on Bribie Island since commencement of harvesting more closely reflect those during the period of Aboriginal occupation than those levels mapped during the plantation era.

The summer of 1998-99 was the wettest for ten years, with approximately 1500mm of rain falling on the southern part of the Island. While the amount of water lying on the Island proved problematic for both archaeological and pine harvesting work, it provided the opportunity to observe high water stands and their relation to archaeological sites. The central barrier swamp was observed by CSR/Sunchip crews to be running, and water from the flowing swamp washed away part of the southern causeway crossing it. Water also covered the northern causeway. Running water covered the haul road into the CSR processing pad, in a relatively low area of former heathland-sedgeland, and numerous freshwater crayfish were observed (Mr C Morris, CSR, pers. comm., 1999). These were most likely sand yabbies (*Cherax robustus*) which are adapted to living in acidic soft waters in peaty sand areas (Short 1995:52). Areas personally observed over the previous nine years to be dry and above nearby swamps were covered by ponds in excess of 1m in depth during this wet summer (Figure 3.8).

Figure 3.8 Water overlying the central track along the eastern dune ridge, looking south from site BI30 (Photo: T. Smith).

Figure 3.9 Free-standing water on the dune ridge at site BI09. The pink tape is a marker for forestry crews of a recorded site. (Photo: T. Smith)

Two examples of the effect of the extended waterlogged areas on the recorded archaeological sites were observed in the north of the Island. Surveys of Site BI09 had previously revealed discontinuous shell and artefact scatters along the undulating north-south trending dune ridge. Probing in these areas, lower in elevation than most of the site, had not detected any subsurface shellfish remains. The reason for this absence became apparent during the summer of 1998-99. The areas were waterlogged, and in some cases there were ponds of free-standing water. While the water and the resources it supported could be exploited, the immediate vicinity would be unsuitable for campsites (Figure 3.9). In the north-west of the Island where the soil type is different (see above) there are no sites recorded other than coastal middens, although the area has been surveyed a number of times over a 20 year period. An indication of why this is so became apparent soon after pine harvesting commenced in the vicinity. The water levels rose quickly and the ground became boggy and waterlogged; definitely unsuitable for camping.

Summary

An appreciation of the past and present environmental context is crucial to understanding Aboriginal behaviour on Bribie Island, particularly settlement location. A rich resource base of plant and animal foods, both marine and terrestrial, was available. There is evidence that prior to the creation of the exotic pine plantation, areas of free-standing water were more common and more permanent than at present. In particular the central swamp would have been deeper and perhaps wider than currently, with increased discharge through the creeks. I consider that the higher water levels, particularly in the central swamp, would have ensured that the north-south dune ridges were the most efficient avenues for movement of people and resources. The vegetation would have been managed more effectively than is currently the case, and was probably associated with occasional firing (as suggested by the presence of *Banksia* spp.). The forested areas would have been more open during Aboriginal settlement.

This Chapter has discussed the environmental context of the study. The next Chapter discusses the cultural context.

CHAPTER 4 CULTURAL CONTEXT

Introduction

The four sections of this chapter include comments on the ethnohistorical sources for the Moreton Region, a discussion of the habits of the Bribie Island people based on the sources, and a review of subsistence-settlement practices on Bribie Island (and in the wider Moreton Bay region) based on the ethnohistorical sources and information from the archaeological record. The fourth section presents various items of stone and non-stone material culture (the latter to partially redress the thesis' emphasis on stone artefacts).

Sources

Most works of anthropological archaeology have a chapter entitled 'Ethnography' or 'Ethnohistory', which implies a scientific description and analysis of cultures based (usually) on (informed) participant observation and/or specialised cultural knowledge from informants. Strictly speaking, no such chapter regarding the Aboriginal inhabitants of Bribie Island is possible. No trained/professional ethnographer or ethnologist was ever particularly concerned with the Bribie Islanders as a distinct group. Instead the observers were in the main explorers, surveyors, clergymen/evangelists, convicts, public servants, journalists, politicians, pastoral colonists, and wealthy businessmen. The information recorded about the Bribie Islanders occurs as part of larger regional 'studies' (the term is used very loosely in this context); the purposes of which were rarely anthropological, as part of observations made only on some cultural/behavioural aspects, or in the form of memoirs of Europeans who observed the Islanders closely only after the basis of their traditional lifestyle had been almost entirely disrupted. Inherent in the sources is a strong bias of progressivism, paternalism and the prejudices of colonialist observation (see Gosden 1999).

The following section is an historical anthology, or a rendering of the European observations and literature between 1799 and the early 1900s. It does not, and cannot, purport to be a whole or unbiased record of the Aboriginal culture of Bribie Island. Nevertheless the review does provide a background against which the discussion of the findings of the technological analysis may be placed.

The People

The Aboriginal inhabitants of Bribie Island are called the Joondaburri (also known as Jindoobarrie, Joondabarrie, Joondoobarrie, Joondubarri, Joondiburri and Djundabora, see Ford and Blake 1998; Meston 1895; Thomson 1967). The Joondaburri are a sub-group of the Undanbi people, speaking a dialect of the Gubbi Gubbi (Kabi Kabi) language group (Steele 1972:171). Welsby (in Thomson 1967) says that the Joondaburri called the island Yarun; the name 'Bribie' is said to have come into common usage last century after the ex-convict Bribie the Basketmaker lived there for some years, and married a Joondaburri woman. Meston provides another version; he argues that *yarun* is sand in the Undanbi language, and that a corruption of *boorabee* (also derived as *borobi* and *dumbripi*) meaning koala (apparently plentiful on Bribie and at Ningi in the past, although almost entirely absent today) is the basis for its name (see Steele 1984).

Matthew Flinders visited Bribie Island on 16 July 1799 in the sloop *Norfolk* with Bongaree, an Aborigine from Sydney. The party observed 'natives with fishing nets over their shoulders' (Steele 1972: 23) who, with their dogs, came down to the beach to greet them. Initially all went well, with Bongaree exchanging his yarn belt for a kangaroo-fur fillet. Flinders offered one of the men a woollen cap, and indicated he wanted his dilly in return, but then a misunderstanding developed over the possession of Flinders' cabbage tree hat. Flinders and his party returned to their boat. After some confusion a spear was thrown; in response Flinders fired his musket and wounded two of the Bribie Aborigines, one in the back and, according to Bongaree, breaking the arm of another. Flinders subsequently named the location Point Skirmish (Steele 1972.15-16). Meston (1895:126) later observed that Bribie was the most historically interesting island in Moreton Bay, partly because 'On that point, therefore, the first Queensland native was shot by a white man.'

Flinders and his party proceeded 'upstream' (believing Pumicestone Passage to be a river) and landed in an unspecified location covered by 'unnutricious grasses' and backed by a stand of eucalypts. There he observed:

> – five or six huts. from twelve to fifteen feet in length, ... standing near each other. They resembled a covered arch-way, rounded at the far end...the sides and roof were equally calculated to shelter the inhabitants from a storm. In one of them was found a small and very light shield, and in another an old net, which had a bag to it, and was knotted and made in the same way as it would have been if made by a European Seine maker. It appeared to be intended for a scoop-net (in Steele 1972:17-18).

Despite Flinders' initial misgivings about venturing far from the shore lest hostile natives be lurking in the grasses (in Steele 1972:17), he apparently demonstrated no compunction about entering the dwellings while the occupants were not at home.

Flinders and his party met with the Joondaburri again on 21 July 1799; despite the unpleasantness of the initial encounter, the Aborigines greeted the party cheerfully and exchanged some items. They did, however, insist that Flinders lay down his musket before approaching (in Steele 1972:26).

Bingle visited Bribie Island in the *Sally* in 1822. Bingle's later records are notoriously inaccurate, with many contradictions with the log of his vessel, not the least over the amount of time spent anchored off Bribie Island, and the location of the vessel. For example, in recording the position of the *Sally* off Point Skirmish on 5 March, the latitude and longitude actually indicate a position on land (Steele 1972:42). Bingle also mentions that the Aborigines had not seen a white man, despite the visit of Flinders in 1799, about which he must have known. Not all those present at Flinders' landings would have died by 1822; in any case, given the oral traditions of Aboriginal people certainly some record of the encounter no doubt remained.

Bingle wrote a paper '*The Natives of Moreton Bay in 1822*' in the years between 1859 (as he mentions Queensland, which became a separate colony in that year) and his death in 1882. Given that at least 37 years had passed since his travels, some aspects of his records may be viewed with cynicism (see Steele 1972). Bingle's narrative is certainly rather romantic, and bordering on fanciful. 'I well remember in particular going into Moreton Bay, now Brisbane, Queensland; my interview with the natives who had not at that early period of the Colony seen a white man…' (in Steele 1972:44). Bingle thereafter recounts what seem to be several days (the *Sally's* log records that she spent two days anchored in Pumicestone Passage) spent with the people of Bribie Island. He gave the Islanders a gift of a tomahawk, and shot birds in order to demonstrate the powers of his gun; he surprised them with his shoes and, like Flinders, impressed the people with his hat. In return, the Joondaburri apparently made 'a great fuss over me, as you may well imagine, giving me their spears, war implements, baskets (made by women), etc., a good collection for the Governor...' (in Steele 1972:45).

> Every morning as I remained in their river they brought me fish in abundance, enough for myself and the ship's crew. When I left – with regret – the whole tribe were in great distress, following me four or five miles down the river running on the beach with their women and children – shouting lamentations, throwing up hands, howling, and bewailing my departure...Fortunately no white man had been in that immediate neighbourhood before us, so we had nothing to fear, and others that followed us reaped the advantage of my friendly visit (in Steele 1972:45-46).

Bingle's narrative, unfortunately, reveals little about the people themselves. Meston (1895) does not mention Bingle's visit at all. Instead he records Oxley's arrival in Pumicestone Passage on 29 November 1823 as the first visit by Europeans since Flinders landed there in 1799 (1895:172; see also Uniacke 1823 in Mackaness 1979).

Oxley was the New South Wales Surveyor-General. On anchoring in Pumicestone Passage his vessel was hailed by a group of Aborigines, one of whom was then discovered to be a European, Thomas Pamphlett. The story of the 'three castaways' Pamphlett, Finnegan and Parsons, and how they came to be in Moreton Bay in 1823, is well known (see Lergessner 1993; Mackaness1979; Meston 1895; Uniacke 1823; Steele1972; Welsby in Thomson 1967). They and another convict, Thompson, left Sydney on March 21 1823 in a large open boat to head south to the Illawarra to obtain timber. A storm blew them northwards and they were eventually shipwrecked on Moreton Island, Thompson having died during the voyage. Possessing no navigational equipment, they believed themselves south of Sydney, rather than 600 miles or so north – an aspect of Pamphlett's narrative widely accepted, but difficult to believe. In any event, in the subsequent months the three moved widely over the Moreton Region in the company of various Aboriginal groups, visiting Noosa, travelling up the Brisbane River, and spending some time on Bribie Island. John Oxley found Pamphlett and Finnegan on Bribie Island and at Toorbul Point respectively on 29 and 30 November 1823; Parsons was found in the same area in September 1824.

Travelling with Oxley was John Uniacke, whose duty it was to report on the suitability of new locations for penal settlements. Uniacke recorded the stories of both Pamphlett and Finnegan, as well as being an excellent observer himself:

> The principal station of the tribe…was about two miles higher up the Pumice-stone River…as they depend principally on fish for their support, they have several huts, at a distance of three or four miles from each other, to which they migrate from time to time as fish become scarce. Their huts are built of long slender wattles, both ends of which are stuck into the ground, so as to form an arch about three feet and a half or four feet high. These are strongly interwoven with rude wicker-work, and the whole is covered with tea-tree bark, in such a manner to be quite impervious to the rain; this forming a spacious and commodious hut, capable of containing from ten to twelve people. In their journeys the women are obliged to carry heavy burthens, consisting of whatever utensils they may possess, together with a large quantity of fern-root, which forms a part of their daily food, and not infrequently two or three children besides. The men carry nothing but a spear, and perhaps a fire-stick (Uniacke 1823 in Mackaness 1979:29).

Uniacke's is the first record of the Joondaburri that goes beyond treating the Aborigines as childlike and curious.

> Each individual of this tribe above the age of six years had the cartilage of the nose perforated, and many of them (especially the children) wore large pieces of stick or bone thrust through it, in such a manner as completely to stop the nostrils. This operation is always performed by the same person, whose office is hereditary, and confers some privileges, such as receiving fish, &c., from the others. It was held in this tribe by a fine intelligent young man, who was called the Doctor by our men. His father held a similar situation in another tribe on the south side of the river.
>
> These tribes are distinguished from each other by the different colours they use in painting their bodies. Those on the north side blacken themselves all over with charcoal and bees' wax, which, with wild honey, they procure in abundance; and those on the south side paint themselves with a sort of red jaspar, which they burn and reduce to a powder. Other tribes make use of a white pigment, with which (having previously blackened themselves) they daub various parts of their body. Their chief appeared to possess an unlimited authority over them...(Uniacke 1823 in Mackaness 1979:30).

Oxley and his party found that 'The Natives, in the intercourse we had with them, appeared to possess a most friendly disposition' (in Mackaness 1979:16). Pamphlett commented: 'Their behaviour to me and my companions had been so invariably kind and generous that, notwithstanding the delight I felt at the idea of returning to my home, I did not leave them without sincere regret' (Uniacke 1823 in Mackaness 1979). Historians and observers after Oxley and Uniacke adopted an opposite view of the Joondaburri, perhaps based on the Joondaburri's own perception of exclusivity as well as that of the other Aboriginal groups in the region.

The Queensland Gazetteer of 1876 refers to Bribie Island as 'until lately inhabited by a tribe of ferocious blacks'. Mathew describes the Joondaburri as 'a very warlike tribe, a race of fine tall men and women, notorious for their cannibalism and a terror to all the mainland tribes' (1910:127). 'The Stradbroke and Morton (*sic*) Island blacks detested cannibalism, and regarded with horror the cannibals of Bribie Island on the other side of the Bay' (Meston 1895:80). It is highly unlikely that cannibalism of the type Mathew and Meston describe actually occurred. References to cannibalism are not uncommon in early accounts, but almost always concern neighbouring groups (rather than the informants themselves). There is never physical evidence. It is probable that 'cannibal' and 'cannibalism' are derogatory terms expressing hatred and abhorrence of enemies and unfriendly neighbours (Dr. Anne Ross, pers. comm., 2003).

Many of the observations on the Bribie Islanders are innately contradictory; even those made by the same author. Welsby is an example:

> The Bribie blacks differed from those on Moreton and Stradbroke Island and their relations with them were far from loving...They were said to have been always a warlike body, the men being particularly well built and courageous, and never in any way fraternising with the blacks further south, being in themselves a totally distinct body of Aboriginals in all ways, and in all habits, as compared with those of Moreton and Stradbroke (in Thomson 1967:18).
>
> Stradbroke, Moreton and Bribie owned distinctive tribes, the two former being friendly and engaging often in warfare with the Nerang Creek dwellers, although it has been known that on more than one occasion *these three have combined* to attack the Tweed and Richmond blacks...(in Thomson 1967:16, emphasis added).

Meston observed that 'each tribe was restricted to its own territory and spoke its own dialect', and that 'in Morton (*sic*) Bay alone there were no less than eight distinct dialects' (1895:82). Certainly different groups had particular 'signifiers'. For example, the left little fingers of coastal women were removed, something the inland groups never did (see Petrie 1992:57). Undoubtedly each group had a strong self-identity and a deep attachment to their country not completely appreciated by all

European observers. The apparent discreteness of basic groupings may have contributed to the European misconstruction of Aboriginal groups, which the Joondaburri somehow came to exemplify, as being entirely distinct from each other despite clear evidence to the contrary. The historical sources, including Meston, indicate a complex web of social and political relationships throughout the Moreton Region and beyond (e.g. Mathew 1910; Meston 1895; Petrie 1992, Whalley 1987; Winterbotham 1957).

The Joondaburri participated in the triennial bunya (*bonyi*) festival, when groups came together from the Clarence in the south, the Burnett in the north, and west to the Moonie and Maranoa in the Blackall Ranges and Bunya Mountains. 'The strangers were received with every hospitality' (Meston 1895:82). Bribie Island's own attraction for large groups was the mullet run, a couple of months or so after the bunya festival (see Petrie 1992).

Physical evidence of the Joondaburri participation in social, political and religious networks is the bora ground at Bellara in the Island's south. At least two other boras once existed on the Island. One, recorded by Welsby with exasperatingly little accuracy, was described as follows:

> ...A little distance up the passage from Skirmish Point, there is a spot named Tarrangiri in the native language, but better known as the White Patch. Not very far from the beach on the inner side near this White Patch are to be found some very fine gum trees, and within a quarter of a mile from the passage there is one of the most perfect bora grounds I have ever seen (in Thomson 1967:157).

White Patch is near the 'primary station' of the Joondaburri referred to by Uniacke. Another bora was observed by the APM crew during the creation of the commercial pine plantation, in the north of the Island near Site BI09. A bulldozer subsequently destroyed the bora (Mr B Youngblutt, former APM foreman, pers.comm., 1991). There is also large bora ground on the nearby mainland at Toorbul Point. Interestingly, Petrie does not mention any of these bora grounds although ignorance of their existence seems to me very surprising in view of Welsby's observation and his own otherwise apparently intimate knowledge of the Island; he merely mentions bora grounds at Humpybong (near Redcliffe), North Pine and Samford (1992:50). In discussing the initiation of young men he states that the inland groups from Ipswich, Cressbrook, Mount Brisbane and Brisbane generally used the bora ground at Samford. Groups from further north, including the Maroochy, Noosa, Kilcoy, Durundur, and Barambah groups used the Humpybong bora ground. He describes the Logan, Amity Point (North Stradbroke Island), North Pine, and Moreton and Bribie Island coastal groups as having 'their ring' at North Pine (Petrie 1992:55). Use of the bora grounds depended on which group 'had the most boys ready for the ceremony, and did the inviting. If a coast tribe invited, then all the others went to the ring that tribe would naturally use, and so on' (Petrie 1992:55).

Bora grounds were also used for other ceremonies, and in dispute resolution. Some sites may have served both ceremonial (including initiation) and dispute settlement purposes, while others were used only for the latter (Satterthwait and Heather 1987:17). This does not however explain Petrie's reference to only three bora grounds used for initiation.

Intermarriage between Aboriginal groups in the Moreton Region, like other areas across Australia, was common practice. 'Tribes intermarried with others, even at long distances...(marriage) of first, second, third or fourth cousins was treated as incest and punished by death ' (Meston 1895:89). The traditions varied with regard to widows and widowers. 'On Bribie Island a widower could marry his wife's sister, but a widow could marry no nearer her husband than a cousin' (Meston 1895:89).

Uniacke's comment that the father of the young man his group called Doctor 'held a similar situation in another tribe on the south side of the river' (Uniacke 1823 in Mackaness 1979:30) also indicates that the Joondaburri were not an isolated group. The accounts of the three castaway convicts also support Joondaburri relationships with neighbouring groups; the castaways travelled north to Noosa and back in the company of various Aboriginal groups. Part of their journey was along the ocean beach on Bribie Island, which they found was also frequented by other travellers. There was a crossing place to Caloundra at the northernmost tip of the Island, also referred to in the legend of two women from Bribie Island who travelled north to Mudjimba (Steele 1984:171). There was a calm weather canoe route between Moreton Island and Bribie Island by which the castaways must have travelled in company with Moreton Island Aborigines, although Steele (1984:87) suggests such travel was rare because of the Bribie people's warlike reputation.

Other information on Joondaburri interaction with neighbouring groups comes from the records of fights, some ceremonial, others that were apparently 'paybacks', and some for which no particular basis is recorded. An example of ceremonial combat (which still resulted in real injuries) was observed by the castaway Pamphlett, and recorded by Uniacke (1823 in Mackaness 1979:37-38). The 'Doctor' of the Joondaburri, referred to above, had been wounded during a hunting expedition about 50 miles north. When the wound had healed, he returned to the area, and undertook combat within a bora. The 'Doctor' speared his opponent through the shoulder on his third cast. On the next day, the 'Doctor' and his opponent's supporters met again in the bora, but as the matter had been settled by the infliction of a wound for a wound, reconciliation followed with a joint hunting party.

Finnegan witnessed a fight about 25 miles south west of Bribie Island (around Redcliffe), which was the result of a 'quarrel'. The Joondaburri women, as well as the men, were involved in fierce physical conflict, resulting in the deaths of two men on both sides. The men were skinned, and Finnegan assumed their comrades then ate them. He observed the skins being smoked on their return journey (Uniacke 1823 in Mackaness 1979:35-36).

A later fight record supports the implication that the Joondaburri were not confined solely to Bribie Island, but also resided in other areas of the Moreton region. In 1852 Dundalli, an adopted Joondaburri, led a fight at York's Hollow in Brisbane between the Ningi Ningi and Bribie groups against the Meganchin (*sic*) (Knight 1898:311). In 1853, a battle near Norman Creek (about 5km from Brisbane) was reported in the *London Illustrated News:*

> between the Ningy-Ningy (*sic*) and Bribie Island clans (then resident near North Brisbane), and the Amity Point and Logan clans (probably resident at South Brisbane at that period)...after a Logan black, called Harry, stole a female of one of the opposite

> tribes. The battle commenced by her father running at Harry with a sharp knife...a most sanguinary conflict ensued...at last the Amity Point and Logan Blacks were routed (they were much less numerous than the others) and it was then discovered that one of the Bribie Islanders was killed (in Steele 1984: 33).

It is likely that, although direct evidence is lacking, traditional landholdings and all associated activities had already been fragmented by the presence of the European colonists resulting in dislocation and increased conflict between groups. Even before the physical arrival of Europeans in the Moreton Region they had influenced the Aboriginal population. Thomas Petrie squatted on land at North Pine in 1859, and observed the deep pockmarks left by smallpox on some of the old men. '...they explained to him how the sickness had come amongst them long before the time of the white people, killing off numbers of their comrades' (Petrie 1992:65). Tuberculosis was also rife in the early days of the colony.

The number of Joondaburri resident on Bribie Island is unclear. Between 600 and 1,000 people were apparently observed on the Island some time during the last century (see Eipper 1841), but this was most likely during some sort of festival. The terrestrial fauna of the Island could not permanently sustain such a large population, even with the associated rich marine resource base. In 1823, Uniacke observed 'about thirty men, sixteen or seventeen women, and about twenty children' (in Mackaness 1979). Hall *et al.* (1991:6) believes that a figure of 70-100 to be most likely, based in part on the number of people who lived in the villages described by Flinders (1799) and Uniacke (1823). This figure gives a population density slightly higher than the 1:1.25sq km postulated by Bowdler for coastal areas of Arnhem Land

and south-western Victoria (1981:107). Lourandos (1997:57) considers this may be an underestimate given the effects of diseases such as smallpox.

Resettlement and its consequences

In 1877, the first reserve for Aborigines was formed near White Patch under the management of Thomas Petrie. Petrie was a member of a prominent early colonial family; his father had been appointed Superintendent of Works for the Moreton Bay Colony in 1837, and the family stayed on after the colony was opened to free settlement in 1842. It would appear from correspondence held at the Queensland State Archives that Petrie may have instigated the establishment of the settlement:

> Hon Minister for Lands
>
> I have the honour to communicate – necessary information – my proposition respecting the Aborigines of Brisbane and others in forming a fishing establishment on Bribie's Island.
>
> 1st to select a place to build a permanent town (?) for the req. natives for such an establishment.
> 2nd A European to instruct.
> 3rd Fish and oil to go to the Pine River storekeeper at a fair price – supply such rations at my orders.
> 4th Myself to inspect every month or three months (Queensland State Archives [QSA] LAN4980/77, dated 23 April 1877).

Petrie wrote again to the Lands Department on 22 May 1877:

> I have visited Bribie Island and spent four days in traversing it.
>
> I went up the passage between it and the mainland fifteen miles and then returned. The Aborigines having reported to me that it was less suitable for settlement further north.
>
> The place I thought most suitable is situated at Beacon No. 30 and 32 about ten (?) miles up the passage. Turtle and fish are very abundant in this place and there is fine high ground with about two hundred acres of fine grass (?) in one patch. There is also other good land in the neighbourhood. I went across the Island from between no.30 and 32 in an easterly direction about 7 miles. There

> is an abundance of fresh water at the place I selected and in fact on many other parts of the Island. There are 44 adults and nine under twenty one. Among them there is one half cast woman and three half cast children.
>
> Bananas are growing well opposite Turbul *(sic)*, and the land is quite good at No. 30 and 32 beacon and there is plenty of land at the Place *(sic)* I selected suitable for growing sweet potatoes, melons and other things that do not require a very stiff rich soil. (Brought sample of soil and grasses).
>
> The crew I had in the boat Roderick Redman and six aborigines and I have to report they have done their duty. I will if you wish send in a more full report (QSA LAN 5475/77).

On the same date, W.G.D, a Commissioner for Lands wrote:

> The Commissioners have requested Petrie to send in a more full report. Meanwhile they (?) that the land referred to by him be reserved for the Blacks or it would be better if the whole of Bribie Island could be reserved. This would not it is stated interfere in any way with the white fishermen, who now camp (?) on the mainland.
>
> We have directed to the Blacks to go to (?) after receiving their Blankets at the Pine River – they have now a whale boat and net and it is intended to get them a small boat for laying out the seine. A man has been employed to take charge of the settlement and gear and to see to the curing of the fish caught. Some of the blacks will be rationed whilst assisting to put up a store after which the fish caught and cured will go towards the support of the settlement. The same old man and woman will require to be permanently rationed. Mr Petrie has been authorised to procure supplies for two months in order to avoid the necessity for the Blacks visiting town, and the Police Magistrate has been advised of the arrangement and requested to (?) in keeping the blacks out of Brisbane.

Interestingly, on 9 May 1877 one Maurice Evans made application to the Lands Department for a pastoral lease 'of the area called Bribie Island' at a suggested rate of £2 per square mile. Mr Evans also made the suggestion that perhaps the land could be put up for public auction (QSA LAN4887/77). The Secretary of Lands subsequently made a submission to the Minister that 'a lease for 5 years of Bribie

Island be submitted to Public Auction £2 per square mile p.a. subject to the Aborigines having access to all parts of the island for fishing and hunting' (QSA LAN 4890/77). The Minister's response was brief: 'As an Aboriginal settlement has been encouraged on Bribie Island it is undesirable to lease' (QSA LAN4890/77).

Petrie's proposed settlement was established, and about 50 people were gathered together. They were supplied with a boat, fishing net, and harpoons for dugong:

> They had to work in exchange for their rations, catching fish and curing them, and making dugong, shark, and stingaree oils. These and sometimes a turtle, were all sold in Brisbane in exchange for the rations, which afterwards were doled out to the blacks by an old man, who, with his wife, was engaged to live on the island (Petrie 1992:214).

Petrie visited the reserve about once a month. When the government changed in 1879, the reserve was closed and most of its inhabitants dispersed. By the late 1800s it would appear that many of the Joondaburri had died or been scattered around other settlements. Certainly, the traditional way of life on Bribie Island had ended. 'There is now in 1894 but one man and one woman to represent the race of the Joondoobarrie' (Meston 1895:127). The woman was almost certainly Kalmakuta (Mrs. Alma Turner), who died in 1897. It was Meston, in his capacity as Protector of Aborigines under the *Aborigines Protection and Sale of Opium Act 1897*, who oversaw the relocation of Brisbane-based Aborigines to reserves at Deebing Creek and Fraser Island (Cryle 1992). In 1913 Welsby wrote that no Joondaburri existed, whilst on Moreton and Stradbroke 'a few of the earlier tribes still remain' (1967:16).

Mathew's observations are poignant:

> Of all the aborigines, young and old, known to me personally between 1865 and 1870, only three or four pure blacks and two half-castes were alive in 1906. The remnants of the Kabi and Wakka tribes are now gathered together, along with blacks from more distant parts, at the Barambah aboriginal reserve. Formerly, every station had a number of aboriginal families, who regarded it specially as their home. Now there are no camps on the runs, no organised hunts, no corroborees. A feeble old straggler may be occasionally seen alive, clinging to some loved haunt, but the centre of aboriginal life now is at the Government reserve (1910:80).

Mathew's, Meston's and Welsby's observations that the people of Bribie Island and the surrounding areas had died out or disappeared have proved to be unfounded. While traditional lifestyles have disappeared in part, the descendants of the people of Bribie Island and other Moreton Bay Aborigines represent a dynamic community with many elements of their culture still intact.

Subsistence and settlement in the Moreton Region

The Aborigines of the Moreton Region had available to them a rich resource base, particularly marine and littoral resources, a veritable 'seafood supermarket' (Hall 1982: 87). This resource base afforded the groups a relatively sedentary lifestyle, in that there was no need to relocate to pursue different types of food only seasonally available. The Reverend John Gregor observed in 1846:

> Their condition is one of plenty...It is a great mistake to suppose that the Aborigines of these districts have not an abundance of food. Throughout the whole year the supply is plentiful, and two hours exertion generally secures them enough to satisfy their wants for twenty-four (in Hall 1982:85).

Daily subsistence activities are most commonly recorded as fishing by men, and fern root collection and processing by women (see Uniacke 1823 in Mackaness 1979).

Other subsistence activities included shellfish gathering, hunting of terrestrial mammals and reptiles, birds and plant foods (see Hall 1982:85).

Flinders (1799) and Uniacke (1823) observed the Joondaburri fishing in parties either with seine-type nets requiring co-operative use, or with the 'tow-row' scoop net common in many areas of Moreton Bay. The constant use of the nets caused the men to develop protuberances on their wrists; these were the mark of a fisherman (Petrie 1992:73). Weirs were also constructed to catch fish. Fish that were difficult to net, or present only in small numbers, were speared. Leftover fish were closely wrapped in grass to exclude flies, and then hung in dillies (Petrie 1992). Women traditionally did not fish, but with the introduction of European rods and lines adopted the practice (Petrie 1992:73). There is no evidence, however, that they subsequently took over fishing from the men to any degree.

Fred Campbell, a member of a well respected Moreton Bay family, reported schools of sea mullet more than a quarter of a mile long (Welsby in Thomson 1967:86). Petrie (1992:72) describes mullet fishing techniques. When a large school was sighted, a dozen or so men would enter the water with hand nets and then their colleagues on shore would throw sticks and stones into the water seaward of the shoal. The frightened fish would then dart shoreward, where the nets would be quickly closed around them. 'Father has seen the blackfellows hardly able to draw their nets to shore, they were so full' (Petrie 1992:72).

This technique is similar to another, described by Petrie (1992) and also Welsby (in Thomson 1967), used to catch schooling fish like tailor as well as flathead which were subsequently speared or netted. Rather than throwing objects into the water to scare the fish towards shallow water, dolphins were used to drive the fish. The dolphins were attracted by beating spears on the water or by men calling to them, and in response turned towards the shore with the fish swimming before them. The dolphins swam among the men as the fish were netted or speared, and took fish offered to them on the tips of spears (Petrie 1992:69-72). 'So well did the Aborigines and porpoises understand each other that the blacks laid claim to individuals in the same way they do with dogs, and it was death by the law to kill or injure any one of these' (Welsby, in Thomson 1967:92).

There was no seasonality in fishing in Moreton Bay as fish are available all year round, although species and numbers vary (see Walters 1987). Hall (1982:86, 1984) describes fishing with dolphins as an adaptive strategy for summer months when some species were less plentiful. It is impossible to quantify the amount of fish available to the Joondaburri and other neighbouring groups as fish stocks and numbers have been affected by a century of commercial fishing. It is interesting to note, however, that the average annual catch of just three species - yellowfin bream (*Acanthropagrus australis*), dusky flathead (*Platycephalus fuscus*) and tailor (*Pomatomus saltaltrix*) - by recreational anglers in Pumicestone Passage for 2001 was 43 tonnes. Commercial fishing is now illegal in the Passage, and recreational bag limits have been steadily reduced since 1993 (The Courier Mail 7 December 2002). Bag limits imposed by the Department of Fisheries control the number of fish legally retained by recreational anglers, and set limits on the size of fish retained related to their breeding potential and population maintenance. In recent years there has been an increase in the popularity of sport fishing, where all fish caught are released, and therefore the reported annual catch may be underestimated. There is no reason to believe that the Aboriginal inhabitants of the Moreton Bay islands, including Bribie, did not practice similar techniques of releasing undersized fish in order to maintain stocks. Looking beyond the reduced fish stocks caused by previously indiscriminate commercial (and recreational) angling, I infer that the Bribie Islanders had a greater access to fish resources than present-day fishermen.

Dugong were also netted. Today herds of dugong numbering up to 400 occur in Moreton Bay (Preen 1998:366). This does not seem to differ significantly from Welsby's account that a fixed herd of three or four hundred was resident in the Bay year-round in the late 1900s (Welsby, in Thomson 1967:105). However, Welsby also writes of a herd in the winter of 1893 up to three miles long and three hundred yards wide (Welsby in Thomson 1967:105). Certainly sufficient numbers of dugong were present in Moreton Bay in the early 20th century to support a processing plant on North Stradbroke Island (Hall 1982:82). Despite Welsby's account of a permanent resident population of dugong, Petrie states that they were only caught at a 'certain season' (1992:67). Dugong capture, involving a process of netting resulting in the animal's death by drowning, and butchery was an exclusively male occupation. Women and children were not allowed to see the dugong until after butchering was completed and cooking commenced (Petrie 1992:68-69). Green turtles were also common in the Bay, and were taken by net or spear.

Shellfish were an important and reliable staple, their collection performed mainly by women. Their remains form the almost ubiquitous and most visible aspects of the archaeological record on Bribie Island. Eipper (1841:10) observed women gathering large numbers of oysters on the mangrove islands in Pumicestone Passage. They packed these oysters into canoes for transport. Shellfish were usually roasted, although sometimes oysters would be eaten raw. Cooking not only cleansed shellfish, but also made the bivalves easy to open.

Over the past 20 years there have been numerous discussions in anthropological and archaeological literature concerning the viability of tidal, estuarine and surf beach shellfish species as long-term resources, and their resilience to exploitation (see Catterall and Poiner 1984, 1987, Luebbers 1994; Ulm 1995; Walters 1987, 1989). With the exception of Ulm, most discussions have overlooked factors such as duration, frequency and intensity of gathering, and ethnographic information concerning the management of shellfish beds (Ulm 1995:41-42). The most common shellfish species found in middens around the Moreton Bay region, pipi (*Donax deltoides*) and cockle (*Anadara trapezia*), are resilient to exploitation, the latter also among species considered to be at little risk from traditional gathering (Catterall and Poiner 1987:121, Luebbers 1994). Other species posited as having low resilience to exploitation, oyster (*Saccostrea glomerata*) and whelk *(Pyrazus ebeninus)* (Catterall and Poiner 1987), occur relatively less commonly in middens.

The fern root staple was *Blechnum indicum*, bungwall (dingowa on Stradbroke Island). This was collected by the women in great quantities, roasted, scraped and pounded into cakes (Eipper 1841 in Steele 1975; Petrie 1992). From all reports its preparation was a female-only activity – both Eipper and Petrie comment on the constant noise of the chopping when the root was being prepared, and of the sight of busy 'wives' and 'mothers' preparing the root for their families. Strangely, or perhaps not, the only photographic record of the root's preparation is of a man. Other vegetable foods included fresh-water rush roots, wild yams, and the shoots of cabbage-tree palms and common palms. Certain plants, such as cunjevoi, Moreton Bay chestnut, and zamia nuts had to be leached of poison before consumption by putting them into dillies and soaking them in water (Petrie 1992).

Most of the rich avifauna of Moreton Bay was a source of food. Swans were caught from canoes during the moulting season when they could not fly (Petrie 1992:90). Ducks were netted, or grabbed from underneath in swamps. Duck eggs were also a favourite food (Petrie 1992:91). Boomerangs were used to scare birds into nets stretched between trees, and emus were caught in staked out nets (Hall 1982:86)

Kangaroo and wallaby were either caught in nets stretched across clear pockets in forests, or driven into waterholes and speared (Petrie 1992:84-86). Although generally roasted whole like most animal foods (including other marsupials and reptiles), particularly fine skins were first removed for use as rugs and cloaks (possum being the preferred skin for the latter). Possums were caught by either knocking or poking them out of their holes, or chopping sections out of trees (Petrie 1992). Koalas were taken by climbing trees.

The rich and varied local resource base offered the Joondaburri a predictable and secure low-risk environment. This afforded a relatively sedentary lifestyle, with mobility dictated as much by social and ceremonial obligations as by subsistence requirements.

Material culture

The majority of material culture items used by the Joondaburri were, in common with Aboriginal people all over Australia, manufactured from organic materials. However, stone artefacts predominate the known archaeological record on Bribie Island. The material culture items of the Joondaburri did not vary significantly from those used by other Aboriginal groups in the Moreton Region. This review is not an exhaustive inventory of all weapons, tools and utensils employed, but rather a sketch of some of the more common items of a rich material culture. It offers a counterpoint to the otherwise heavy emphasis on stone artefacts within this study.

Many material culture items were made of wood or bark. These included boomerangs, spears, 'waddies', digging sticks, shields, coolamons, and canoes. Petrie described two types of boomerangs, one a 'toy' which returned when thrown and which was also used to frighten birds into nets. The other type of boomerang was used in fighting, and for hunting heavy game. It did not return when thrown, but generally travelled straight for a distance before curving to the right or left. The direction it followed was controlled by the throwing technique. The fighting/hunting boomerangs were heavier, rounder, and less curved than the toys, but were manufactured in the same manner. A curved tree root or branch was selected, initial preparation was with stone axe or adze, and then the boomerang was shaved smooth using a shell (Petrie 1992:100-101).

Petrie (1992:101-102) describes three types of spear. The first, '*kannai*' was made from saplings six to nine feet (1.8m to 2.7m) long, and de-barked using shells (although not specified, oyster shells would be robust enough for this task). A pipi/eugarie shell with a small hole in the centre was then used to sharpen the spear to a point. It is interesting to note that stone artefacts were not used in spear manufacture beyond, presumably, cutting down the sapling. The tip was hardened by fire, and the whole length blackened with the exception of an area about a foot (30cm) from the point, which was scraped white so that it was visible in flight. *Kannai* were used in combat and hunting. The second type of spear was used for fishing. Rather than sharpening the point, three or four spicules of wood about seven inches (17.5cm) in length to act as prongs were attached by fibre or sinew. Ironbark spears were also made, designed for use at close quarters as they were too long and heavy to throw with any accuracy. The 'blanks' were cut to length - about ten feet (3m) - from living trees, and then shaped in the same fashion as the *kannai*. Sometimes stingray barbs were attached to the points using wax and string. These *pi-lar* were essentially fighting spears. The Joondaburri and other Moreton Region Aborigines did not use woomeras or spearthrowers (Meston 1895; Petrie 1992); Bongaree gave one as a gift, but was unsuccessful in explaining its use.

Waddies (clubs or nulla nullas) were made of ironbark and were either tapered at both ends, or broadened to a knob at one end. The former was used for hunting and fighting, while the latter was used solely for fighting (Petrie 1992:103). The women's yam sticks or digging sticks also doubled as their weapons. They were supposedly about six feet (1.8m) long, thick, tapered at one end and 'very sharp' at the other (Petrie 1992:103). This description is rather fanciful, as ethnographic examples of digging stick are rather shorter and better designed for their principal purpose.

Vessels for holding honey, and water, were made from bark, wood, and palm fibre. They were shaped using stone axes and shells, tied at the ends with string, and made waterproof if necessary with bees' wax. Petrie describes some of them as 'really splendid' (1992:106). Canoes were manufactured from stringybark and 'bastard mahogany' trees (Petrie 1992:97). The bark was made pliable with fire, shaped, dried, and the ends tied with cord.

Nets were manufactured from vine fibres. As noted above, the nets were of particularly fine quality. The mesh of the nets varied between small for fish and birds to heavier, more open weave for dugong and kangaroo (Mathew 1910; Meston 1895; Petrie 1992). Other fibres employed for various tasks included treated sinews and tendons, kangaroo fur, and human hair.

Stone items

'It was not every man who had a stone tomahawk [axe or adze] to leave behind him; they were hard to make and therefore not plentiful' (Petrie 1992:104). The blank was shaped, and then ground on wetted sandstone or other rock. When shaped, a handle of strong vine was attached and secured by bees' wax (Petrie 1992:104-105). The University of Queensland Anthropology Museum has in its collection a particularly striking axe grinding stone from Bribie Island. Other 'tomahawks' were used without handles to break bones to get at the marrow (Petrie 1992:105). Petrie (1992:105) also refers to stone knives ornamented with possum fur stuck on with bees' wax, made from reddish-coloured flint stone. Petrie, although a remarkable observer, was no geologist. Red chert (jasper), the Australian equivalent of flint, is not a relatively common raw material. Reddish silcrete, on the other hand, is common over the Moreton Bay region. Despite this inaccuracy, Petrie's other comments on the manufacture of 'knives' are pertinent to the discussion of stone artefacts in later chapters: 'there was no grinding for knives, but they were simply split from the stone, so one can understand how they did not often split to taste, but were perhaps blunt and no good. Sometimes a man would be lucky and get one at the first trial, but at other times he might split ever so many first' (Petrie 1992:105). This is reminiscent of Hayden comments (1977:179; Chapter Two).

Other 'formal' stone implements include grindstones and mullers, and the bevelled pounders characterised by Kamminga (1981) and used for processing bungwall (see also Gillieson and Hall 1982; Hall *et al.* 1989; Hall and Hiscock 1988; Higgins 1988).

Summary

Until the first half of the 19th century the Joondaburri and neighbouring Aboriginal groups inhabited a world that was socially and economically rich. It offered a reliable, predictable, secure low risk environment and a relatively sedentary lifestyle. This lifestyle has been supported by ethnohistorical accounts, and by shellfish remains and other faunal data (Crooks 1982; Hall 1982; 1991; McNiven 1990; Nolan 1986; Smith 1992; Walters 1987).

CHAPTER FIVE METHODS

Introduction

In this chapter I describe the methods employed in the technological analysis of the Bribie Island artefact assemblage. The artefact categories and variables used in the analysis are described and defined. I demonstrate that the methods employed provide a relatively simple but nevertheless highly informative analytical strategy.

The artefacts analysed for this research include artefacts collected during the MRAP surveys in 1981-82, those collected during my BA Honours fieldwork in 1991-92, artefacts and manuports collected by the 1991-1993 University of Queensland 'Field Archaeology' classes, and those recorded by BIFAP 1996-1999. A total of 2133 artefacts and manuports were analysed for this study.

Stoneworking

As a technological analysis is employed in this study, some brief discussion of the principles of stoneworking is appropriate. These are important considerations in the interpretation and understanding of any stone artefact assemblage.

Flaked (or chipped) artefacts are the result of flaking or fracturing a rock by the use of a hammerstone or other percussive instrument. The fracture process is the tensile failure of a brittle solid under loads which exceed the elastic limits of the material, and occurs in rocks when the local stress exceeds the local strength (Hiscock 1988:9). In flaking, the stress is produced by the use of a percussor e.g. hitting the rock with another rock. Flaking often creates distinctive, conchoidal surfaces, so called because of their resemblance to a bivalve shell. This conchoidal fracturing is the mechanism by which most flaked artefacts were or are made; it creates distinct objects that are readily identified as being of human manufacture (Hiscock 1988:9).

Controlled conchoidal fracturing only occurs in rock with certain characteristics (Crabtree 1967 in Hiscock 1988). These rocks are:

1. Homogeneous i.e. uniform in structure;
2. Isotropic i.e. there is no preferred direction of fracture;
3. Hard and inert i.e. resistant to deformation;
4. Rigid i.e. deformation is minimal; and
5. Elastic i.e. deformation is temporary (Hiscock 1988:10).

Rock types that have these characteristics in varying degrees are siliceous rocks such as chert, obsidian, silcrete, quartz and quartzite, and many fine-grained volcanic rocks such trachyte, rhyolite, andesite and basalt.

Definitions

The artefact definitions and the variables used in this study are based on those of Hiscock (1983, 1984, 1988) and McNiven (1992, 1993). The exception is the definition of 'whole flake', explained in detail below. The Bribie Island artefacts were divided into the categories of flaked artefacts (including whole flakes, retouched flakes, broken flakes, flaked pieces and cores); non-flaked artefacts (e.g. ground or abraded); and manuport. The term manuport implies any object transported by humans, and which is generally unmodified. This description certainly applies to the manuports from Bribie Island. However, as no stone naturally occurs on the Island, all stone found there has been imported. The manuport category is therefore included on the basis that these materials served some purpose for the Island's inhabitants and formed part of their material culture. Bevelled artefacts are a subcategory of flaked artefacts. Some of the artefacts analysed exhibited characteristics of two or more categories. For example, some flaked and non-flaked artefacts also exhibited evidence of bevelling. In these circumstances, the dominant characteristic determined the classification of the artefact.

The categories accommodate the entire stone assemblage from Bribie Island, and therefore enable observations on the stone procurement and reduction behaviour of the inhabitants.

Artefact definitions

Flake

Flakes are pieces of stone struck from a core. They exhibit a range of features showing they have been struck. These features include a percussor or hammer impact point (point of force application or PFA), and a bulb of percussion on the ventral surface which may also exhibit fissure lines, ripples, and/or eraillure scars.
The PFA is usually evidenced by ringcracks. Flakes exhibit feather, step, hinge or outrepasse terminations.

Whole flakes

Whole flakes exhibit some or all of the diagnostic features of flakes. Usually, only whole or 'complete', i.e. unbroken flakes, are used in the reconstruction of reduction sequences. During the initial sorting of the artefacts from Bribie Island, I noted flakes that fitted the accepted definition of 'flake' as well as flakes which, although *almost* complete, would be consigned to the mandatory classification of 'broken flake'. There were a large number of these flakes, exhibiting *all* of the attributes selected for analysis of complete flakes, with one small exception: a bit of them was missing. As these artefacts would otherwise satisfy the definition of 'flake', and be measured as a flake, I decided to include them in the whole flake category. To ensure that all of the flakes so included were not arbitrarily or subjectively selected simply because they appeared to have most of their parts substantially intact, I determined that artefacts with 95% or more of their peripheries intact would form the category 'whole flake'. In practice, this meant using a full circle protractor to measure the peripheries. Those flakes with at least 342^0 of their periphery intact were designated whole flakes; those with less than 342^0 of their periphery intact were designated broken flakes.

Broken flakes

Broken flakes are those broken during or after manufacture, and, for the purposes of this study, have less than 95% (342^0) of their periphery intact.

Retouched flakes

Retouched flakes are simply flakes that have had one or more subsequent flakes removed from the ventral surface, or derived from the ventral surface. In classifying retouched flakes, I used McNiven's definition. 'Retouching flakes must exhibit an impact point, and have an arbitrary minimum length of 2mm to allow differentiation from unintentional use-wear flaking and /or edge damage resulting from other factors such as trampling' (McNiven1992:5).

Cores

Cores are the pieces of stone from which flakes are struck. They exhibit one or more negative (i.e. concave) scars with impact initiation points, but no positive (i.e. convex) scars.

Flaked pieces

Flaked pieces are flaked or chipped artefacts which cannot be classified as flakes, broken flakes, or cores.

Bevelled artefacts

Bevelled artefacts are those exhibiting one or more bevelled margins, usually associated with striations and/or polish. These artefacts form a subcategory of flaked artefacts.

Non-flaked artefacts

Non-flaked artefacts are those which exhibit no evidence of flaking, but exhibit ground, abraded or pitted surfaces. For the purposes of this study they are referred to as 'other artefacts'.

Manuports

Manuports are any pieces of stone from the Bribie Island assemblage which do not fit into any of the above categories.

Variables

The variables are those attributes observed and recorded for each artefact described within each artefact category. They also include the site number and artefact number within each site. Unless otherwise indicated, these variables are based on those used by Hiscock (1984; 1988), Hiscock and Hall (1988) and McNiven (1992). Most attributes were measured using stainless steel Vernier callipers and a Sartorius electronic scale.

Raw Material

The raw material is the source from which the artefact was manufactured. Raw materials may indicate transportation of the core or of the artefact itself. Different raw material types also have different properties (see above).

Weight

Weight is measured to the nearest 0.1g. Weight is a basic attribute in all stone artefact analyses.

Length

Length is measured to the nearest millimetre (mm). For flakes and retouched flakes, length is measured on the ventral surface and is the distance between the percussion axis and the distal margin. It does not necessarily correspond with the maximum dimension of the flake.

For broken flakes where the percussion axis is incomplete, it is the maximum dimension.

For cores, length is the maximum distance between a platform and opposite side of the core.

For the remaining technical categories, length is the maximum dimension.

The length of artefacts is measured in order to provide some sort of comparison between the flakes and the cores associated with them. It may be an indicator of whether the cores were simply being used in a profane or opportunistic manner in order simply to produce flakes, or whether there was intention to maximise the potential of the core in order to produce the longest flake possible.

Width

Width is measured in mm on flakes on the ventral surface. It is the distance between the lateral margins at a point where an imaginary line evenly bisects the length at a right angle. It does not necessarily correspond to the widest part of the flake.

Thickness

Thickness is the distance in mm between the dorsal and ventral surfaces at the intersection of the length and width dimensions. It does not necessarily correspond to the thickest part of the flake.

Platform attributes

The platform is the surface struck by the percussor or hammerstone and represents a small area of a core's striking platform (McNiven 1992). Three platform attributes were recorded. Platform thickness and width are used to calculate the platform area. Relatively large platform areas, considered in association with other attributes such as flake width, are generally indicative of:

- high amounts of force application;
- imprecise applications of force;
- little if any platform preparation (see below); and
- moderate to high core rotation. (Hiscock 1986:44)

Relatively small platform areas are indicative of:

- low to moderate applications of force;
- precise applications of force;
- frequent overhang removal; and
- low to moderate core rotation. (Hiscock 1986:44).

It must be stressed that all these values are relative, and specific to the assemblage. The platform attributes are recorded for this study to provide data on the reduction sequence and opportunism of manufacture.

The form of the striking platform itself influences the form of the flake. A cortical surface on a platform may be softer than a freshly exposed surface, and offer more control to the knapper. That is, the hammerstone will be less likely to slide away from the striking surface, and will achieve more 'bite'. The knapper may also shape the platform by removing a flake or several small flakes, and then strike the platform to remove the flake.

Platform thickness

Platform thickness is measured on flakes in mm, at a right angle across the surface of the platform between the ventral PFA and the dorsal margin of the platform. It also indicates how far from the edge of the core the blow was struck.

Platform width

Platform width is the distance in mm between the proximal ends of both lateral margins.

Platform type

This describes the surface of the platform, which may be cortical, flaked (a single flake scar), multiple flaked (two flake scars), facetted (several small flake scars), crushed/collapsed (the platform has been partially or wholly shattered or removed), or a combination of these features. These attributes were recorded as c, f, ff, fac, cr or cl. The nature of the cortex, whether geological or cobble, was also recorded.

Platform preparation

This attributes records the presence or absence of platform preparation and the type of the preparation e.g. generalised, facetted, overhang removal or ridge forming.

Cortex percentage

This records the amount of cortex present on the dorsal surface and platform of a flake. It is used to determine whether a flake is primary, secondary, or tertiary, and is indicative of core rotation. The types of cortex present e.g. cobble or geological may indicate the source of the raw material. Presence or absence of cortex may indicate whether prepared or unprepared cores were transported.

Retouch

Retouch records the presence of retouch flake scars >2mm, and their position on the flake. Retouch flake scars must have an impact point and be longer than 2mm in order to differentiate them from unintentional usewear flaking and/or edge damage from other factors such as trampling (McNiven 1992).

Maximum retouch

Maximum retouch is the length of the longest retouch flake scars, measured in mm from the initiation point to the termination.

Dorsal scars

On flakes, these are negative (concave) scars. The scars indicate core rotation.

Breakage

Specific types of breakage on flakes are recorded. These include transverse breaks (resulting in proximal, medial and distal portions of a flake) and longitudinal breaks (left and right split cones). Snap fractures or combinations of transverse/longitudinal breaks were also recorded. Transverse fractures generally occur after manufacture and include the effects of treadage, while longitudinal fractures generally occur during the manufacturing process. Breakage may also indicate the quality of the raw materials, the intensity of site usage, or post depositional disturbance e.g. 4wd traffic. The skill of the artisan has also been suggested as a factor (Dr A. Ross, pers. comm., 1999); while this may be a consideration it drifts into the typological realm and is therefore discarded here.

Number of platforms

This is the number of striking platforms observed on a core. Striking platforms are the surfaces from which cores are struck. The number of platforms indicates the amount and nature of use of the core, and also conservation of the raw material. Numbers of platforms also indicate whether the core was multidirectional or unidirectional.

Number of scars

This records the number of negative flake scars on cores i.e. those exhibiting initiation points and differentiates the scars from impact points resulting from natural or accidental percussion.

Maximum scar

This is the length in mm of the longest flake scar with an initiation point on cores.

Minimum scar

This is the length in mm of the shortest flake scar with an initiation point on cores.

Bevel width

On artefacts whose predominant characteristic is a bevelled edge, this is the distance measured in mm at right angles across the bevel.

Comments

This attribute was used for notes about the artefacts. For artefacts collected and initially analysed by the Field Archaeology classes from the University of Queensland, the attribute included the ascribed Field Specimen (FS) number. For other artefacts, notes included whether the artefact appeared to be the result of bipolar manufacture, and various other distinctive features.

Recording

Measurements on the artefacts in the laboratory were made using a set of Sartorius electronic scales, stainless steel Vernier callipers, and a 360^0 protractor. In the field, measurements were made with a hand held electronic scale, stainless steel Vernier callipers, and a 360^0 protractor.

All artefact variables were recorded on specific artefact analysis sheets and each artefact was given a unique number. This information was then entered into a PC-based Access database designed by Dr. Jon Prangnell of the School of Social Science, The University of Queensland. In addition to the information recorded on the artefact analysis sheets, I also entered site size (in square metres), site type, location, elevation, and environment. These specifics had been recorded during all surveys on Bribie Island between 1981 and the present. The database facilitated reporting on the results of the analysis as well as statistical manipulation. These results are presented in the following chapter.

CHAPTER SIX RESULTS

Introduction

In presenting the results of the artefact analysis, this chapter considers the findings for each artefact category in turn, and concludes that the pattern of rationing and distance from source- decay predicted in Chapter One is not found. I identified 269 whole flakes, 422 broken flakes, 51 retouched flakes, 768 flaked pieces, 88 cores, 30 bevelled artefacts, 68 other artefacts, and 437 manuports from the total of 2133 artefacts found on 43 sites (Figure 6.1). Table 6.1 summarises the site and artefact data. Table 6.2 shows the percentages of artefacts by technical category.

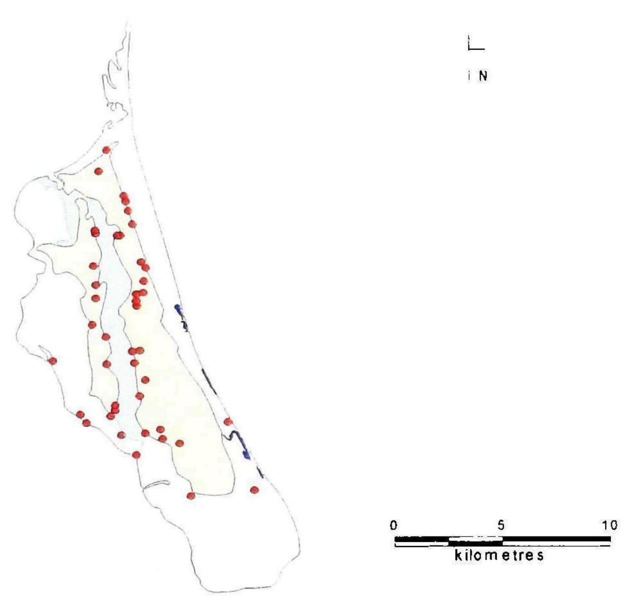

Figure 6.1 The 43 sites

Table 6.1 Site and artefact summary

Site	Location	Artefacts (n)	WF	BF	RF	FP	C	OA	BA	M
BI02	West	55	8	7	0	20	2	0	0	18
BI03	West	108	24	22	5	10	14	7	5	21
BI04	East	1	0	1	0	0	0	0	0	0
BI09	East	574	41	98	5	259	8	11	7	145
BI11	West	67	15	11	1	9	4	3	5	19
BI13	East	60	8	13	2	14	8	2	0	13
BI14	East	5	0	0	1	1	2	0	0	1
BI15	East	8	3	0	0	2	1	2	0	0
BI16	East	265	40	77	3	124	8	6	1	6
BI18	East	6	2	0	1	1	1	1	0	0
BI19	East	21	3	3	1	12	0	0	0	2
BI20	East	6	1	1	0	1	0	0	0	3
BI21	East	32	2	13	2	10	1	0	0	4
BI22	East	3	1	2	0	0	0	0	0	0
BI23	East	1	0	0	0	1	0	0	0	0
BI24	East	3	0	0	0	0	0	0	0	3
BI30	East	232	49	64	7	76	2	3	0	31
BI31	East	31	0	2	0	23	1	0	0	5
BI33	East	82	3	8	4	37	1	8	0	21
BI34	East	6	0	0	0	0	0	0	0	6
BI35	East	107	14	18	2	24	6	6	1	36
BI36	East	30	3	5	2	6	2	1	0	11
BI37	East	3	0	2	0	1	0	0	0	0
BI39	East	38	1	2	1	13	1	0	0	20
BI40	East	1	0	0	0	0	0	1	0	0
BI41	West	52	11	8	0	22	3	0	2	6
BI42	West	1	0	1	0	0	0	0	0	0
BI43	West	10	4	0	0	3	1	1	0	1
BI45	West	4	0	0	0	1	2	0	0	1
BI48	West	6	1	1	0	2	0	1	1	0
BI49	West	19	5	4	1	2	2	2	1	2
BI55	West	2	0	1	0	0	0	0	0	1
BI56	West	3	0	0	0	1	0	0	0	2
BI58	West	2	0	0	0	0	0	0	1	1
BI63	East	1	0	0	1	0	0	0	0	0
BI67	West	23	2	2	7	6	2	1	3	0
BI68	East	85	6	16	0	34	8	0	0	21
BI72	West	1	0	0	0	0	0	1	0	0
BI73	West	119	13	30	1	36	4	6	3	26
BI74	West	44	5	5	1	15	2	5	0	11
BI83	East	2	1	0	1	0	0	0	0	0
BI85	East	10	2	2	2	2	2	0	0	0
BI89	East	4	1	3	0	0	0	0	0	0

WHOLE FLAKES

Whole flakes (n=269) occurred at 28 of the 43 sites, 10 on the western dune ridge and 18 on the eastern dune ridges (Figure 6.2). Figure 6.3 shows the numbers of flakes at each site.

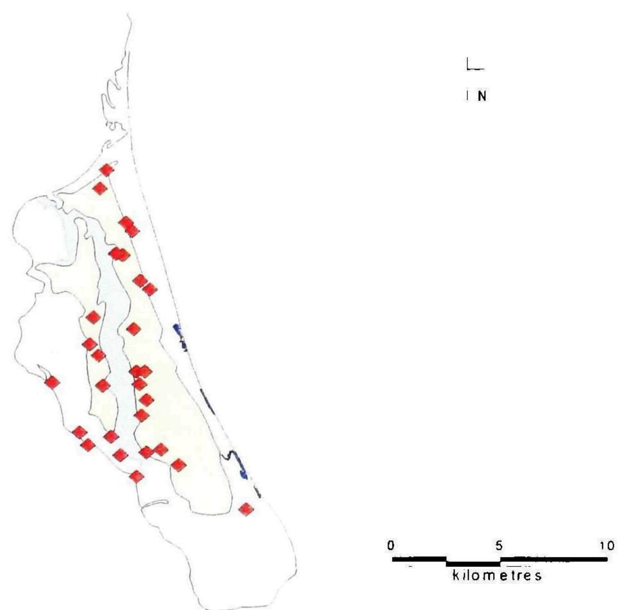

Figure 6.2 Distribution of whole flakes

Overwhelmingly the most common raw material was silcrete, comprising 202 (75% of the total). The second most common stone was chert (n22) and then quartz (n14). Figure 6.4 shows the numbers by raw material type. The longest flake was 84mm from site BI43 and the smallest flake was 4mm from site BI03. Table 6.3 presents the range of maximum, minimum and average lengths of whole flakes by site for the Island. In order to identify any correlation between whole flake length and the distance from the hypothesised import points, BI09 and BI67, average flake lengths were plotted according to distance from those points (graphically represented in Figures 6.5 and 6.6). The plotting was repeated for retouched flakes, broken flakes, flaked pieces and cores.

Table 6.2 Percentages of artefacts by technical category

Technical category	Bevelled Artefact	Broken Flake	Core	Flaked Piece	Manuport	Other	Retouch Flake	Whole Flake
Number	30	422	88	768	437	68	51	269
% total	1.4	19.8	4.1	36.0	20.5	3.1	2.4	12.6

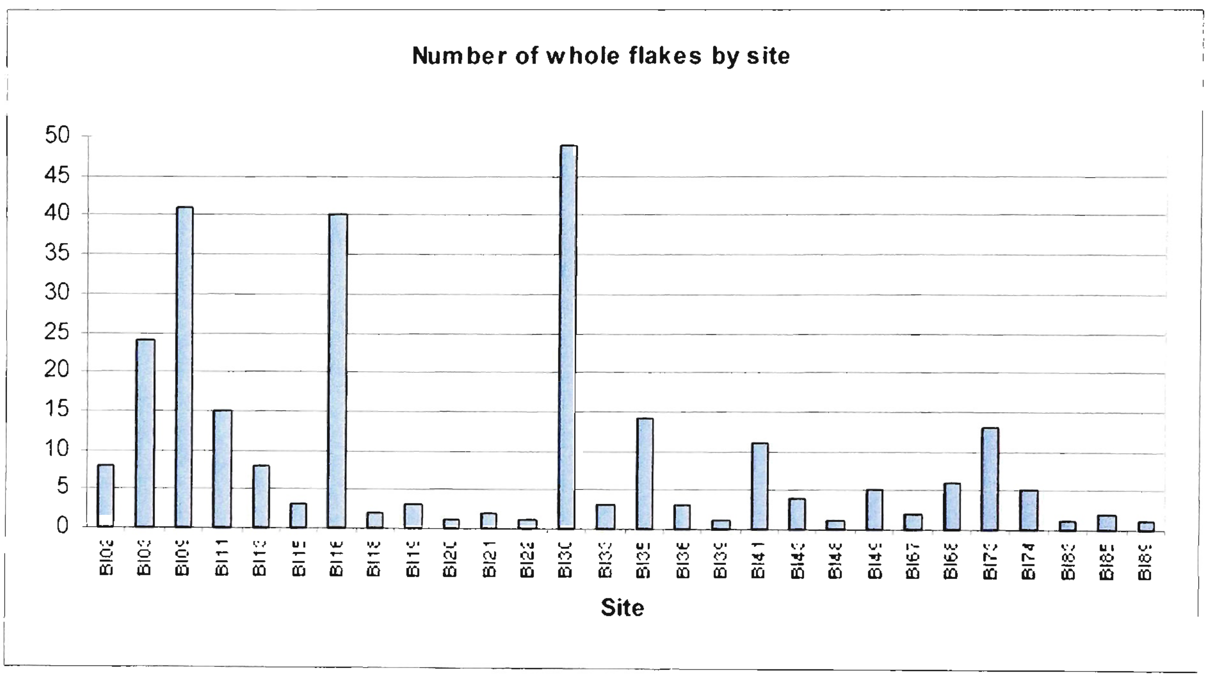

Figure 6.3 Number of whole flakes by site

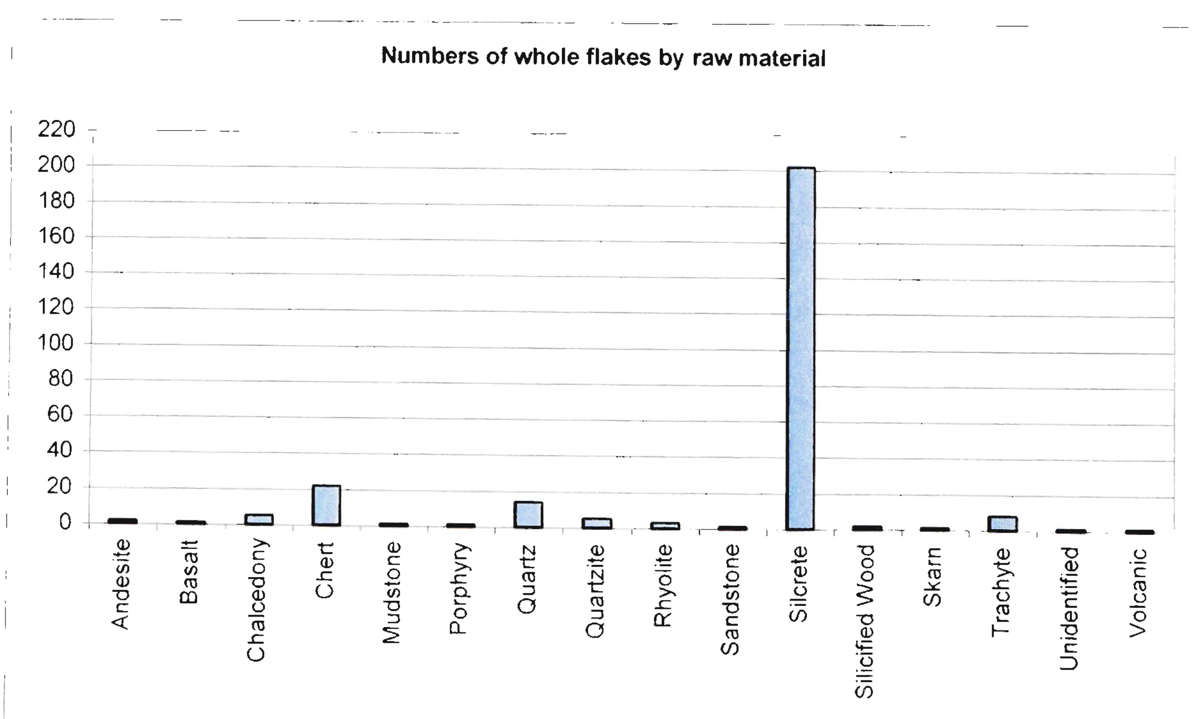

Figure 6.4 Number of whole flakes by raw material

Table 6.3 Maximum minimum and average lengths of whole flakes by site

Site	Location	Count	Maximum Length	Minimum Length	Average Length
BI02	West	8	52	9	28.5
BI03	West	24	77	4	35.6
BI09	East	41	56	10	27.0
BI11	West	15	65	28	44.3
BI13	East	8	39	14	27.6
BI15	East	3	32	24	29.3
BI16	East	40	59	13	30.4
BI18	East	2	47	14	30.5
BI19	East	3	36	27	32
BI20	East	1	15	15	15
BI21	East	2	18	13	15.5
BI22	East	1	14	14	14
BI30	East	49	63	7	23.4
BI33	East	3	22	17	19
BI35	East	14	44	17	30.3
BI36	East	3	38	22	30.7
BI39	East	1	37	37	37
BI41	West	11	48	12	25.5
BI43	West	4	84	17	43.3
BI48	West	1	78	78	78
BI49	West	5	64	21	38
BI67	West	2	50	40	45
BI68	East	6	48	10	26.2
BI73	West	13	48	18	31.3
BI74	West	5	33	19	23.4
BI83	East	1	29	29	29
BI85	East	2	30	24	27
BI89	East	1	32	32	32

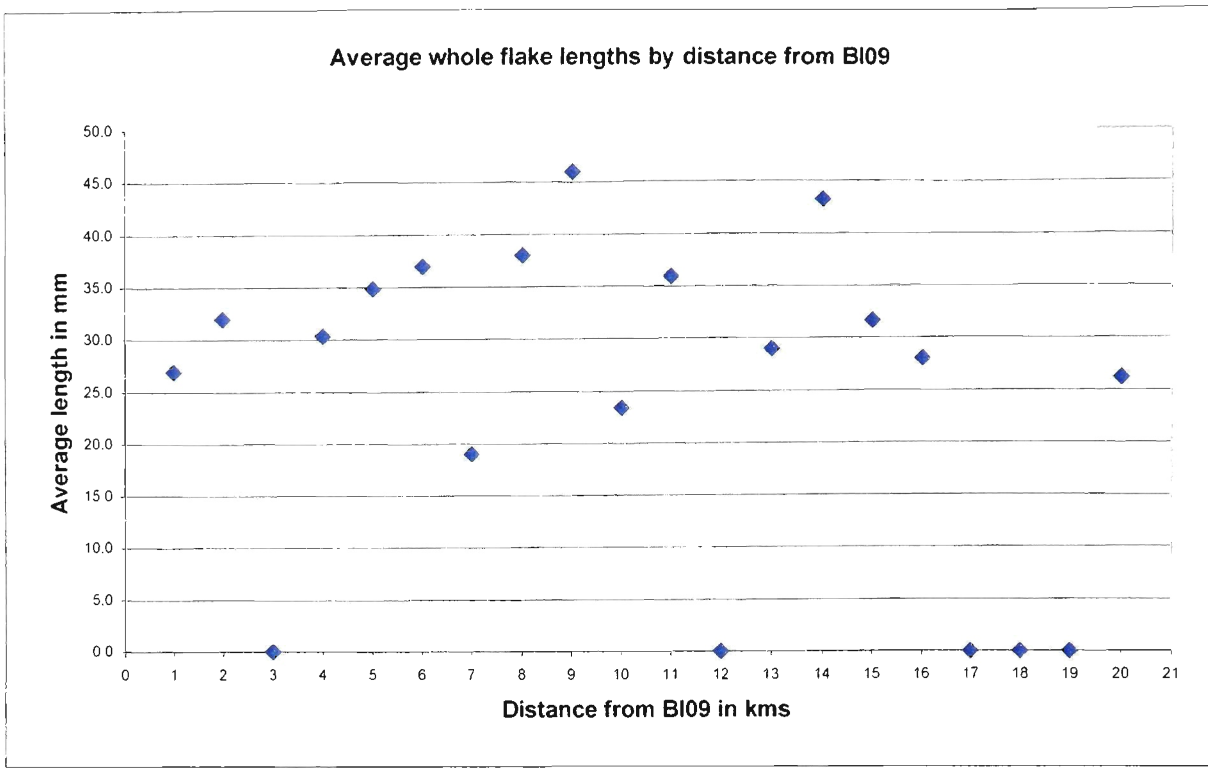

Figure 6.5 Average whole flake lengths by distance from BI09

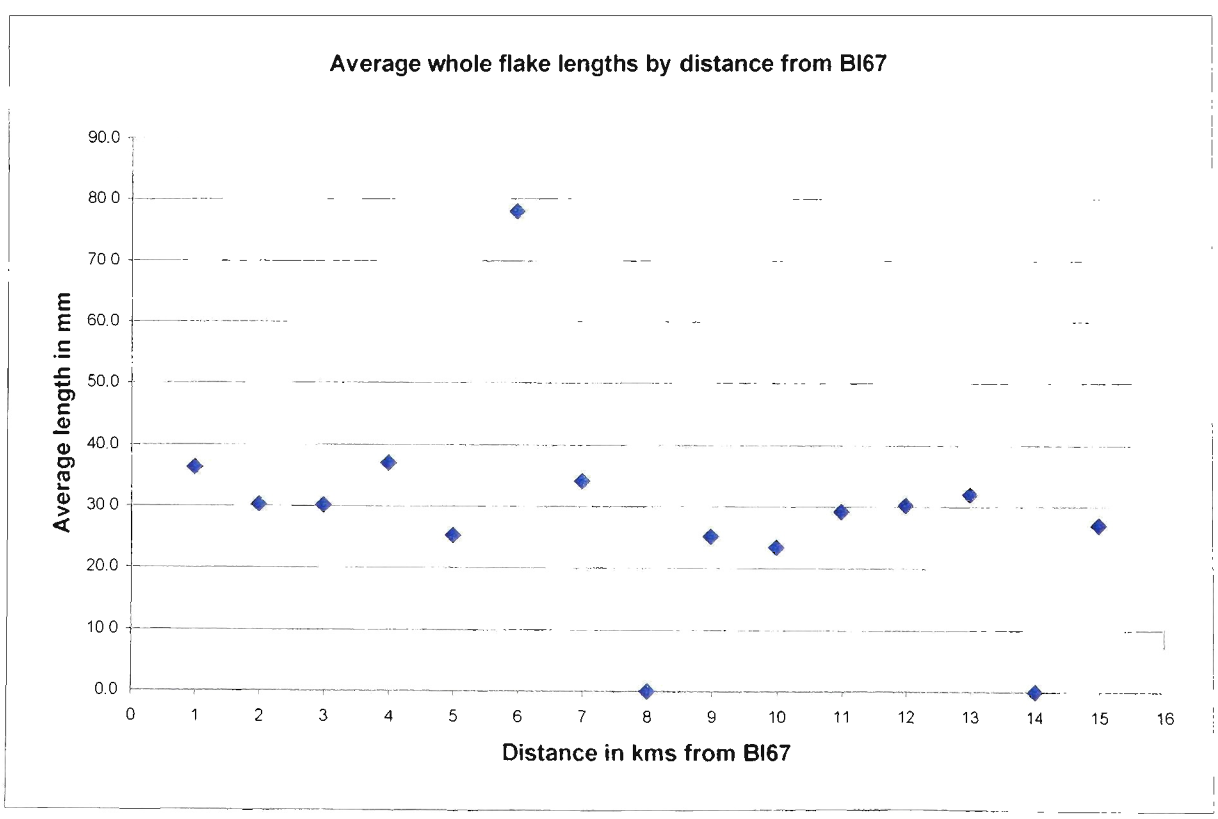

Figure 6.6. Average whole flake lengths by distance from BI67

No distance-decay patterns were apparent. Application of a Pearson ratio test demonstrated no correlation between whole flake length and distance from BI09 ($r = 0.052$, $df = 26$, $p \geq 0.05$) or BI67 ($r = 0.207$, $df = 26$, $p \geq 0.05$). Simple plotting of the average length of the flakes from west to east indicated that the average length of flakes on the eastern dune ridge was marginally smaller (Figure 6.7) and suggested another avenue of enquiry. Application of an independent group *t* test to the average length of whole flakes from the western and eastern sides of the central swale revealed distinct statistical differences ($t = -3.0686$, $df = 26$, $p = \leq 0.01$). The average length of whole flakes on the eastern side of the Island was less than that on the western side. This discovery determined the further statistical analyses on other technological categories, i.e. are there statistically significant differences between artefacts from the western and eastern sides of the central swamp.

Table 6.4 summarises width by site. Although the flakes from the western side of the Island tend to be wider than the eastern flakes, no statistically significant differences were found ($p \geq 0.05$). Table 6.5 summarises the average platform areas by site. One whole flake each from BI21 and BI36 were excluded from average platform areas as their area could not be calculated because their platforms were crushed or collapsed. The largest maximum platform areas ($1200mm^2$ and $656mm^2$) occur on the western side of the Island. However there is a wide variation in the platform areas, and the application of a standard *t* test revealed no statistically significant difference between platform area and site location ($p \geq 0.05$).

Table 6.6 shows percentages of cortex by site and location. The majority of whole flakes (203, 75.5% of the total) exhibit no cortex. The presence of cortex on 66 whole flakes from across the Island nevertheless suggests that minimally reduced cores were transported away from any import points. With the exception of a chert flake from BI03 which exhibited chalky geological or primary cortex, all cortex recorded was of the type associated with cobbles.

Table 6.7 shows the types of whole flake platforms. The most common platform type is simply flaked (167, or 62%) indicative of core preparation and/or rotation. The data presented in Table 6.8 show that 205 whole flakes (76%) do not show any indication of platform preparation while 61 whole flakes (approximately 22%) show only generalised platform preparation.

Table 6.9 shows the number of dorsal scars on whole flakes by site. 82% of all whole flakes have two or more dorsal scars.

Other features noted during the analysis of the whole flakes is that four (two from the west of the island and two from the east) exhibit evidence of bipolar manufacture. Fourteen whole flakes (five from the west of the Island and nine from the east) resemble the bevelled flakes characterised by McNiven (1991). One hundred and thirty one whole flakes (48.7%) had edge damage on one or more margins.

In short, contrary to earlier predictions there are no clear patterns to the distribution and size of whole flakes or raw materials. There are however statistically significant differences between the lengths of flakes from the eastern and western dune ridges.

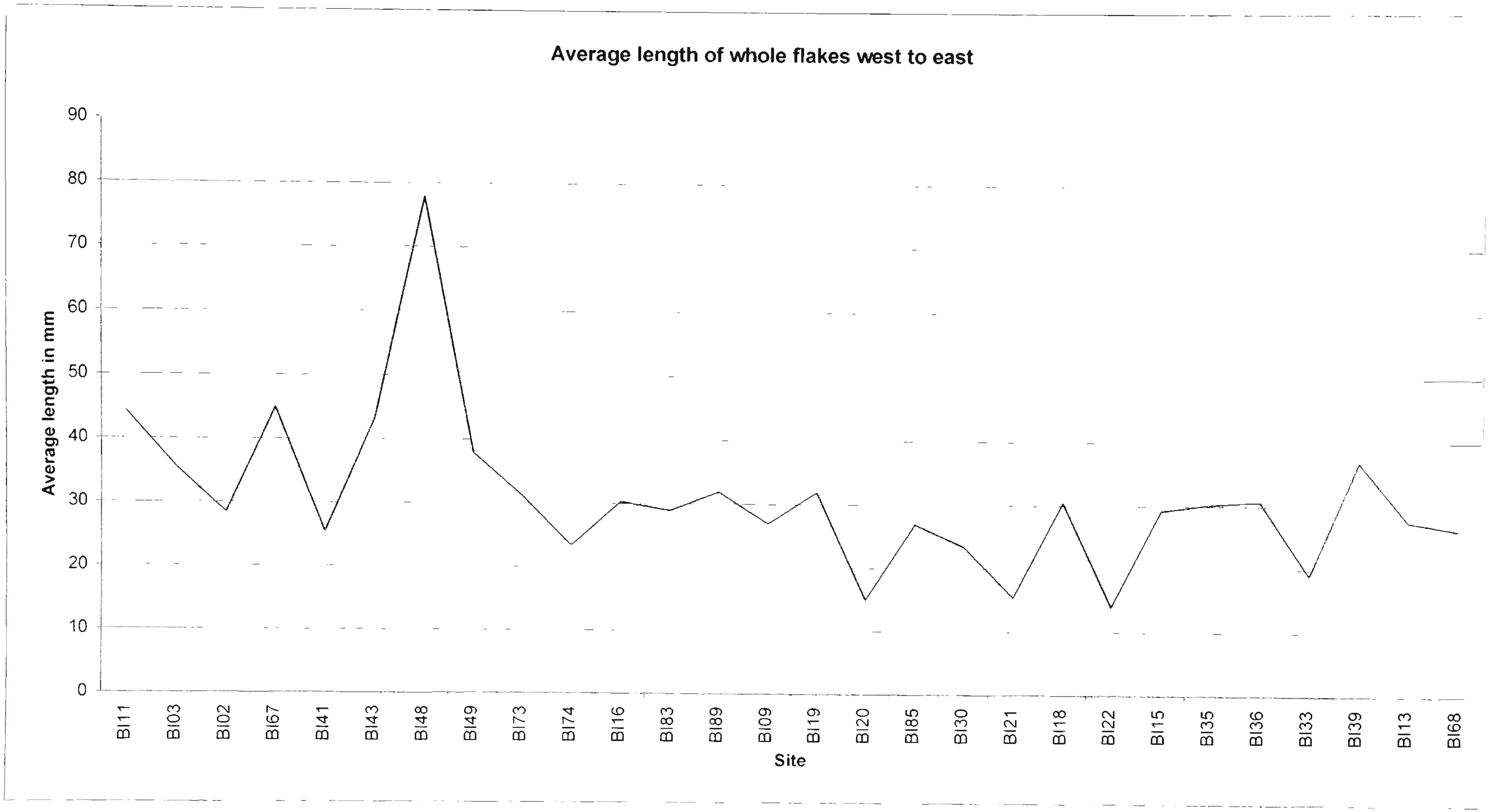

Figure 6.7 Average length of whole flakes west to east

Table 6.4 Average whole flake width by site

Site	Location	Count	Maximum Width	Minimum Width	Average Width
BI02	West	8	42	11	21.9
BI03	West	24	51	17	29.0
BI09	East	41	60	6	23.1
BI11	West	15	46	18	32.8
BI13	East	8	27	12	21.0
BI15	East	3	32	16	22.7
BI16	East	40	53	8	24.7
BI18	East	2	28	18	23.0
BI19	East	3	21	18	19.7
BI20	East	1	17	17	17.0
BI21	East	2	16	13	14.5
BI22	East	1	11	11	11.0
BI30	East	49	43	4	19.0
BI33	East	3	32	11	21.7
BI35	East	14	44	13	28.1
BI36	East	3	48	18	30.3
BI39	East	1	38	38	38.0
BI41	West	11	33	10	17.2
BI43	West	4	78	26	47.3
BI48	West	1	48	48	48.0
BI49	West	5	49	22	38.0
BI67	West	2	49	26	37.5
BI68	East	6	30	12	20.2
BI73	West	13	37	13	25.1
BI74	West	5	28	10	22.6
BI83	East	1	23	23	23.0
BI85	East	2	11	10	10.5
BI89	East	1	28	28	28.0

Table 6.5 Whole flake average platform areas by site

Site	Location	Number	Maximum area	Minimum area	Average area
BI02	West	8	252	9	87.8
BI03	West	24	570	24	143.8
BI09	East	41	504	9	112.1
BI11	West	15	656	52	220.9
BI13	East	8	112	24	55.3
BI15	East	3	290	42	132.3
BI16	East	40	406	3	106.1
BI18	East	2	110	15	62.5
BI19	East	3	160	56	109.3
BI20	East	1	105	105	105
BI21	East	1	24	24	24
BI22	East	1	16	16	1
BI30	East	49	574	2	87.6
BI33	East	3	84	56	72
BI35	East	14	238	22	123.3
BI36	East	2	161	144	152.5
BI39	East	1	208	208	208
BI41	West	11	112	14	47.1
BI43	West	4	1200	68	378
BI48	West	1	28	28	28
BI49	West	5	544	34	338.8
BI67	West	2	161	56	108.5
BI68	East	6	98	24	53.7
BI73	West	13	300	40	139.8
BI74	West	5	209	16	110
BI83	East	1	27	27	27
BI85	East	2	12	10	11
BI89	East	1	168	168	168

Table 6.6 Percentage of cortex on whole flakes by site and location

Site	Location	Nil cortex	5%	10%	15%	20%	25%	30%	40%	50%	Total No.
BI09	East	34	3	1	0	2	0	0	1	0	41
BI13	East	5	2	0	0	0	0	1	0	0	8
BI15	East	2	1	0	0	0	0	0	0	0	3
BI16	East	28	5	2	0	1	1	1	1	1	40
BI18	East	0	0	0	0	0	0	0	0	2	2
BI19	East	2	0	1	0	0	0	0	0	0	3
BI20	East	1	0	0	0	0	0	0	0	0	1
BI21	East	2	0	0	0	0	0	0	0	0	2
BI22	East	1	0	0	0	0	0	0	0	0	1
BI30	East	41	4	0	0	1	1	0	1	1	49
BI33	East	1	0	0	0	0	0	1	0	1	3
BI35	East	10	0	1	0	0	0	2	1	0	14
BI36	East	3	0	0	0	0	0	0	0	0	3
BI39	East	0	0	1	0	0	0	0	0	0	1
BI68	East	6	0	0	0	0	0	0	0	0	6
BI83	East	0	0	0	0	0	0	0	1	0	1
BI85	East	2	0	0	0	0	0	0	0	0	2
BI89	East	1	0	0	0	0	0	0	0	0	1
BI02	West	6	1	0	0	1	0	0	0	0	8
BI11	West	13	1	1	0	0	0	0	0	0	15
BI41	West	9	1	1	0	0	0	0	0	0	11
BI43	West	3	0	0	0	0	0	0	0	1	4
BI48	West	1	0	0	0	0	0	0	0	0	1
BI49	West	3	0	0	0	0	0	0	0	2	5
BI67	West	1	0	1	0	0	0	0	0	0	2
BI73	West	11	0	0	0	0	0	1	0	1	13
BI74	West	4	0	0	0	0	0	0	0	1	5
BI03	West	13	3	2	0	1	1	0	3	1	24

Table 6.7 Whole flake platform types

Site	Location	Cortical	F	Cr	FF	FF/cr	Coll	Bevelled	F/cortical	Cr/coll	Ground	Total
BI02	West	1	7	0	0	0	0	0	0	0	0	8
BI03	West	2	16	1	5	0	0	0	0	0	0	24
BI09	East	2	26	3	7	1	0	2	0	0	0	41
BI11	West	1	9	1	4	0	0	0	0	0	0	15
BI13	East	0	5	1	1	0	1	0	0	0	0	8
BI15	East	0	2	0	1	0	0	0	0	0	0	3
BI16	East	2	25	2	6	0	4	0	1	0	0	40
BI18	East	2	0	0	0	0	0	0	0	0	0	2
BI19	East	0	1	0	2	0	0	0	0	0	0	3
BI20	East	0	1	0	0	0	0	0	0	0	0	1
BI21	East	0	1	1	0	0	0	0	0	0	0	2
BI22	East	0	1	0	0	0	0	0	0	0	0	1
BI30	East	3	33	2	5	0	3	0	1	2	0	49
BI33	East	0	3	0	0	0	0	0	0	0	0	3
BI35	East	0	9	0	4	0	0	1	0	0	0	14
BI36	East	0	2	0	0	0	0	0	0	0	1	3
BI39	East	1	0	0	0	0	0	0	0	0	0	1
BI41	West	0	4	2	3	0	1	0	1	0	0	11
BI43	West	0	1	1	2	0	0	0	0	0	0	4
BI48	West	0	1	0	0	0	0	0	0	0	0	1
BI49	West	0	3	0	2	0	0	0	0	0	0	5
BI67	East	0	1	0	1	0	0	0	0	0	0	2
BI68	East	0	4	1	1	0	0	0	0	0	0	6
BI73	West	1	7	0	4	0	1	0	0	0	0	13
BI74	West	1	3	0	1	0	0	0	0	0	0	5
BI83	East	1	0	0	0	0	0	0	0	0	0	1
BI85	East	0	1	1	0	0	0	0	0	0	0	2
BI89	East	0	1	0	0	0	0	0	0	0	0	1
Number		17	167	16	49	1	10	3	3	2	1	269

Key: F= flaked; Cr = crushed; FF = multiple flaked; Coll =collapsed

Table 6.8 Whole flake platform preparation

Site	Location	Nil	Generalised	OHR	Ridged	Total
BI02	West	7	1	0	0	8
BI03	West	20	4	0	0	24
BI09	East	33	8	0	0	41
BI11	West	11	3	0	1	15
BI13	East	7	1	0	0	8
BI15	East	2	0	1	0	3
BI16	East	29	10	1	0	40
BI18	East	2	0	0	0	2
B19	East	2	1	0	0	3
BI20	East	1	0	0	0	1
BI21	East	2	0	0	0	2
BI22	East	1	0	0	0	1
BI30	East	40	9	0	0	49
BI33	East	2	1	0	0	3
B35	East	10	4	0	0	14
BI36	East	2	1	0	0	3
BI39	East	0	1	0	0	1
BI41	West	8	3	0	0	11
BI43	West	2	2	0	0	4
BI48	West	1	0	0	0	1
BI49	West	4	1	0	0	5
BI67	West	1	1	0	0	2
BI68	East	4	2	0	0	6
BI73	West	6	7	0	0	13
BI74	West	4	1	0	0	5
BI83	East	1	0	0	0	1
BI85	East	2	0	0	0	2
BI89	East	1	0	0	0	1
Total		205	61	2	1	269

Table 6.9 Numbers of dorsal scars on whole flakes

Site	Location	WF with 0 scars	1scar	2 scars	3 scars	4 scars	5 scars	6 scars	7 scars	8 scars	9 scars	10 scars	Total
BI02	West	1	4	2	1	0	0	0	0	0	0	0	8
BI03	West	4	0	7	3	6	3	0	0	1	0	0	24
BI09	East	8	8	19	5	1	0	0	0	0	0	0	41
BI11	West	3	1	1	3	4	0	3	0	0	0	0	15
BI13	East	0	3	2	2	0	0	0	1	0	0	0	8
BI15	East	0	0	0	3	0	0	0	0	0	0	0	3
BI16	East	8	5	11	12	2	1	1	0	0	0	0	40
BI18	East	2	0	0	0	0	0	0	0	0	0	0	2
BI19	East	0	1	0	0	1	1	0	0	0	0	0	3
BI20	East	0	1	0	0	0	0	0	0	0	0	0	1
BI21	East	0	0	0	2	0	0	0	0	0	0	0	2
BI22	East	0	1	0	0	0	0	0	0	0	0	0	1
BI30	East	12	18	13	6	0	0	0	0	0	0	0	49
BI33	East	1	0	2	0	0	0	0	0	0	0	0	3
BI35	East	2	1	5	3	2	1	0	0	0	0	0	14
BI36	East	0	0	1	2	0	0	0	0	0	0	0	3
BI39	East	0	0	0	0	0	0	0	1	0	0	0	1
BI41	West	0	0	2	5	1	3	0	0	0	0	0	11
BI43	West	1	0	3	0	0	0	0	0	0	0	0	4
BI48	West	1	0	0	0	0	0	0	0	0	0	0	1
BI49	West	1	0	1	1	0	1	0	0	0	0	1	5
BI67	West	0	0	0	2	0	0	0	0	0	0	0	2
BI68	East	1	0	3	1	0	0	0	1	0	0	0	6
BI73	West	2	1	3	5	2	0	0	0	0	0	0	13
BI74	West	1	1	2	1	0	0	0	0	0	0	0	5
BI83	East	0	0	1	0	0	0	0	0	0	0	0	1
BI85	East	0	0	2	0	0	0	0	0	0	0	0	2
BI89	East	0	0	0	0	1	0	0	0	0	0	0	1

RETOUCHED FLAKES

Retouched flakes (n=51) occurred at 21 of the 43 sites (Figure 6.8). The number of retouched flakes at each site is shown in Figure 6.9. The most common raw material was silcrete (42), followed by chert (4) and chalcedony (2). Andesite, quartz and rhyolite each accounted for one retouched flake (Figure 6.10).

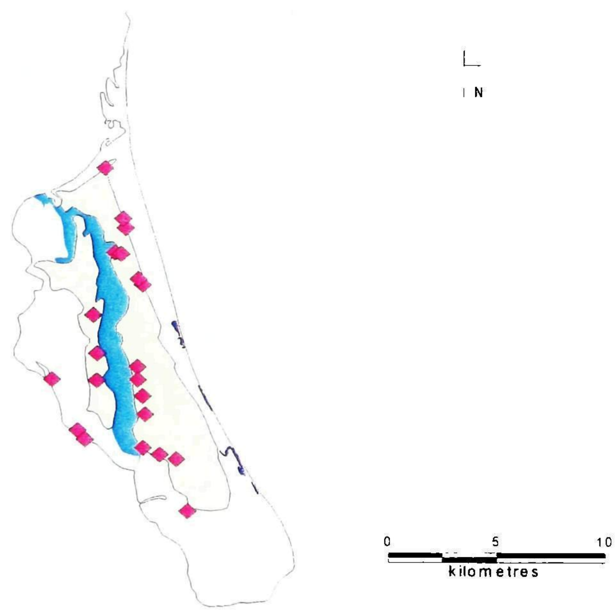

Figure 6.8 Distribution of retouched flakes

Table 6.10 presents the average length of retouched flakes by site. Application of a standard *t* test revealed no statistically significant differences ($t= -1.237$, $df=49$, $p\geq0.05$). Similar results were obtained for the average width. Table 6.11 shows the average maximum length of retouch scars by site and location; again the patterning appears random.

Thirty-four retouched flakes (over 66%) had one or more dorsal flake scars present; two had ten dorsal scars. The most common platform type was, as for the whole flakes, simply flaked which accounted for 24 (47%) of the platform types. Other platform

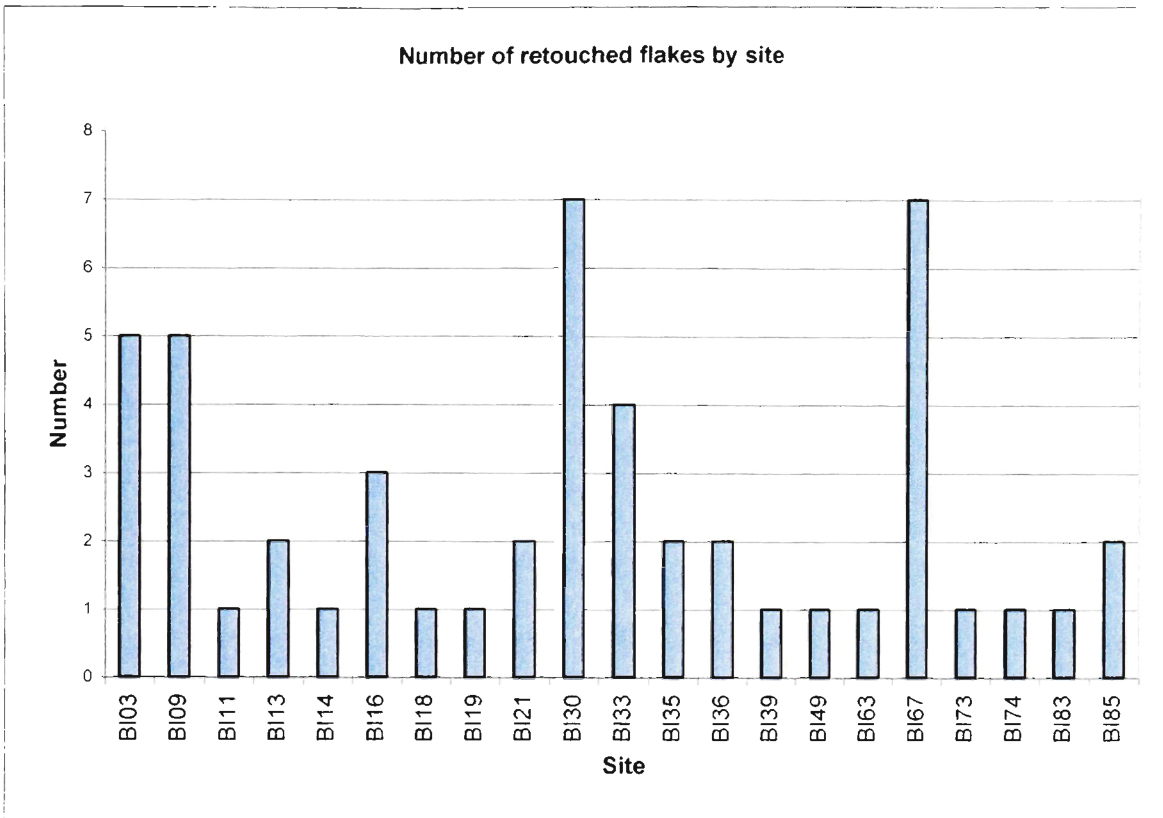

Figure 6.9 Number of retouched flakes by site

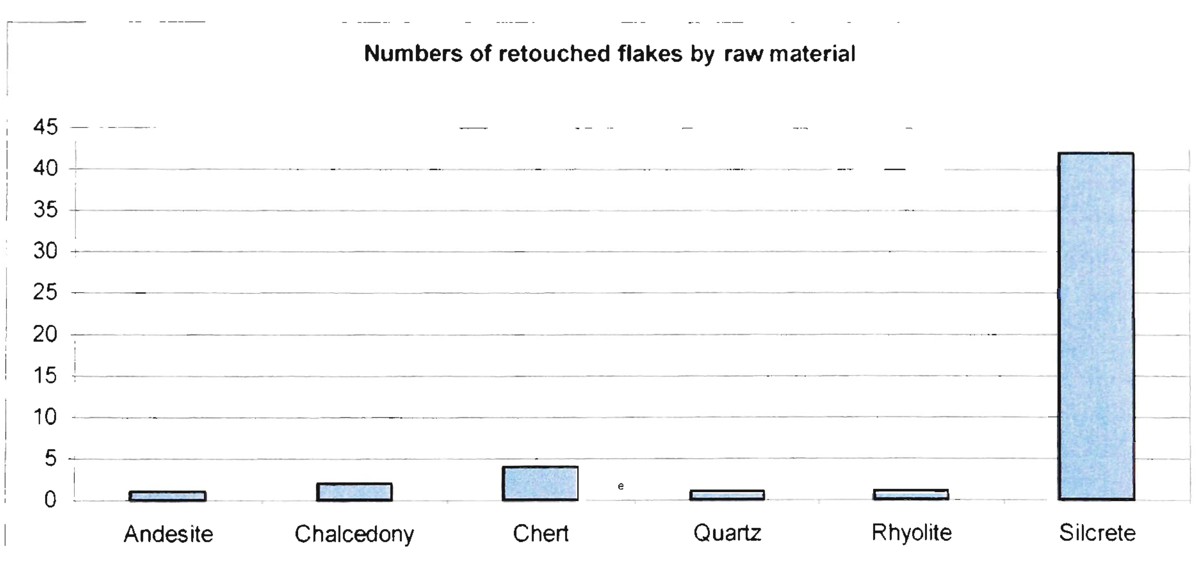

Figure 6.10 Number of retouched flakes by raw material

Table 6.10 Average length in mm of retouched flakes by site

Site	Location	Number	Maximum Length	Minimum Length	Average Length
BI03	West	5	47	30	38.0
BI09	East	5	68	19	39.8
BI11	West	1	28	28	28.0
BI13	East	2	58	44	51.0
BI14	East	1	63	63	63.0
BI16	East	3	34	28	31.7
BI18	East	1	49	49	49.0
BI19	East	1	49	49	49.0
BI21	East	2	49	35	42.0
BI30	East	7	51	21	33.3
BI33	East	4	51	24	35.5
BI35	East	2	36	35	35.5
BI36	East	2	55	26	40.5
BI39	East	1	18	18	18.0
BI49	West	1	27	27	27.0
BI63	East	1	97	97	97.0
BI67	West	7	124	16	63.9
BI73	West	1	47	47	47.0
BI74	West	1	141	141	141.0
BI83	East	1	86	86	86.0
BI85	East	2	104	98	101.0

Table 6.11 Average maximum length in mm of retouch scars by site

Site	Location	Number	Maximum Retouch	Minimum Retouch	Average Retouch
BI03	West	5	17	7	11
BI09	East	5	30	3	12
BI11	West	1	7	7	7
BI13	East	2	36	12	24
BI14	East	1	38	38	38
BI16	East	3	9	4	6
BI18	East	1	22	22	22
BI19	East	1	25	25	25
BI21	East	2	24	13	19
BI30	East	7	18	4	10
BI33	East	4	12	3	8
BI35	East	2	10	4	7
BI36	East	2	51	10	31
BI39	East	1	4	4	4
BI49	West	1	7	7	7
BI63	East	1	29	29	29
BI67	West	7	43	4	22
BI73	West	1	32	32	32
BI74	West	1	11	11	11
BI83	East	1	86	86	86
BI85	East	2	53	11	32

types recorded were absent (seven, 13.7%), crushed (five, almost 10%), multiple flaked (11, 21.5%), cortical (three, approximately 6%), flaked/cortical and incomplete (one each, approximately 2%). Thirty-seven of the retouched flakes (approximately 72.5%) showed no evidence of platform preparation, while 13 (approximately 25.5%) show only generalised platform preparation. One platform exhibited overhang removal. Thirty-four retouched flakes had no cortex; the percentage of cortex on the remaining 17 varied from 5% to 50% (Table 6.12). With the exception of a silcrete retouched flake from BI68 that had geological cortex present, all cortex recorded was of the cobble type. Of the 51 retouched flakes two exhibited indications of bevelling, and one showed evidence of bipolar manufacture.

The size and distribution of retouched flakes and raw materials do not conform to the predicted pattern.

Table 6.12 Cortex percentage on retouched flakes

Site	Location	Cortex percentage	Number	Raw Material
BI03	West	10	1	Chert
BI09	East	30	1	Quartz
BI11	West	40	1	Silcrete
BI13	East	50	1	Silcrete
BI14	East	30	1	Silcrete
BI30	East	20	1	Silcrete
BI30	East	30	1	Silcrete
BI30	East	50	1	Silcrete
BI33	East	25	1	Silcrete
BI33	East	50	1	Silcrete
BI67	West	5	1	Silcrete
BI67	West	20	1	Silcrete
BI67	West	40	1	Silcrete
BI67	West	50	1	Andesite
BI74	West	20	1	Silcrete
BI85	East	10	1	Silcrete
BI85	East	30	1	Silcrete

BROKEN FLAKES

Broken flakes (n=422) occurred at 29 sites (Figure 6.11). The frequency at each site is given in Figure 6.12. Silcrete was by far the most abundant of the 13 raw materials identified, accounting for 335 (approximately 79%) of the broken flakes (Figure 6.13). Table 6.13 presents the average lengths by site, and indicates random patterning. Three hundred and thirty exhibited no dorsal scarring, the remaining 92 exhibited a range of between one and seven dorsal scars.

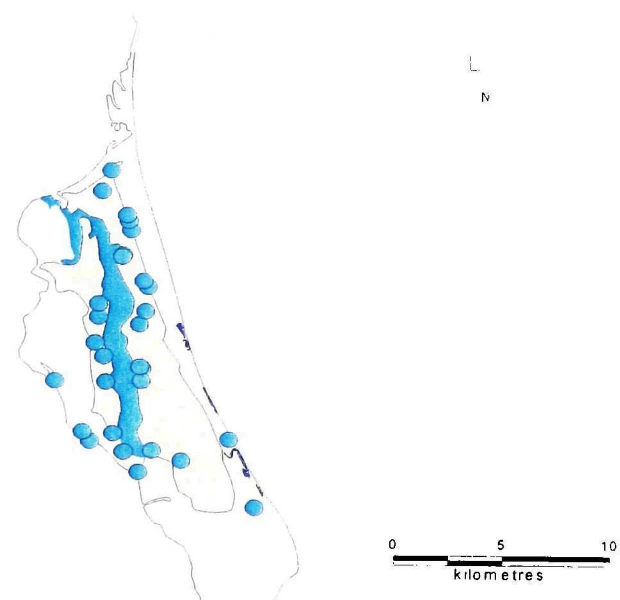

Figure 6.11 Distribution of broken flakes

Transverse breaks (indicative of post-depositional breakage such as trampling) accounted for only 49 broken flakes (approx. 11.5%). Breakages that commonly occur during manufacture and result in a right or left split cone numbered only 43 (just over 10%). There were 13 longitudinal fractures or breaks that did not fit into the split cone categories. The most common type of breakage was 'other' (n=317, 75%), i.e. a break that was not solely transverse or longitudinal but which combined these traits.

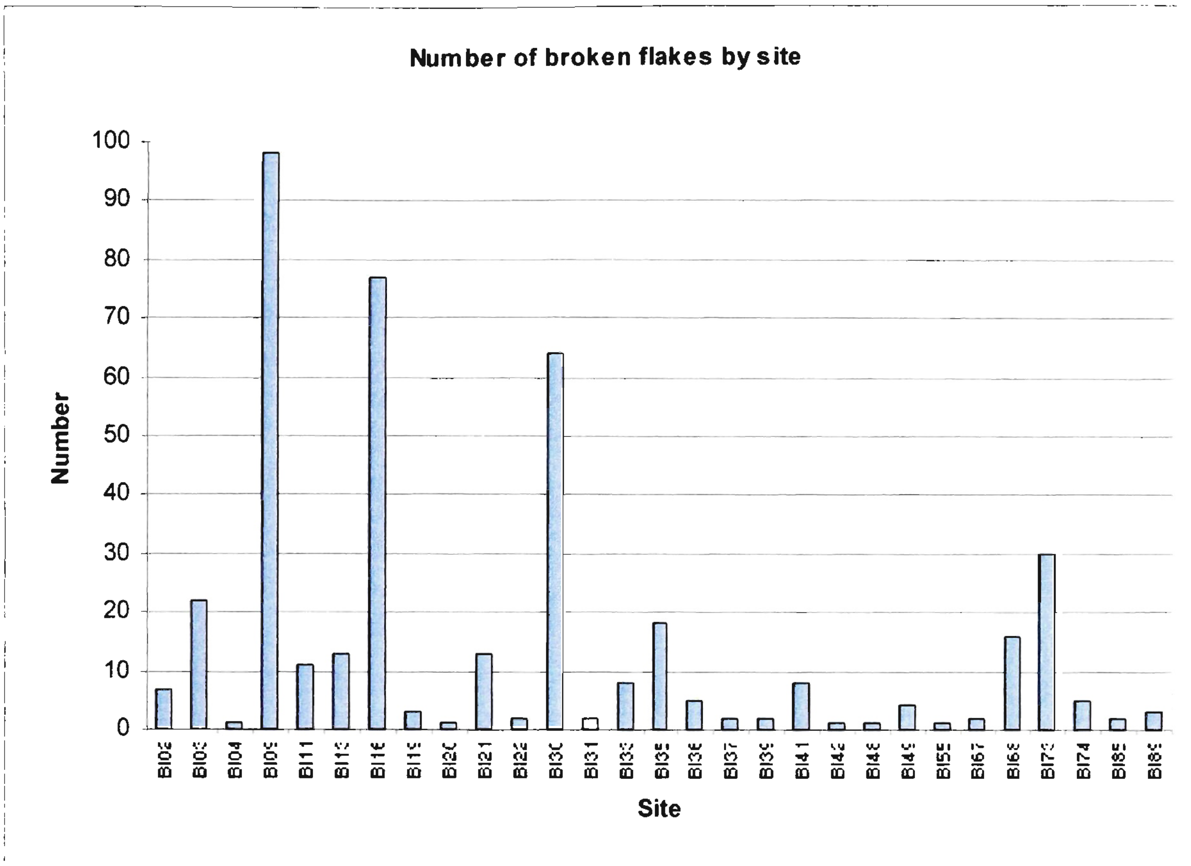

Figure 6.12 Number of broken flakes by site

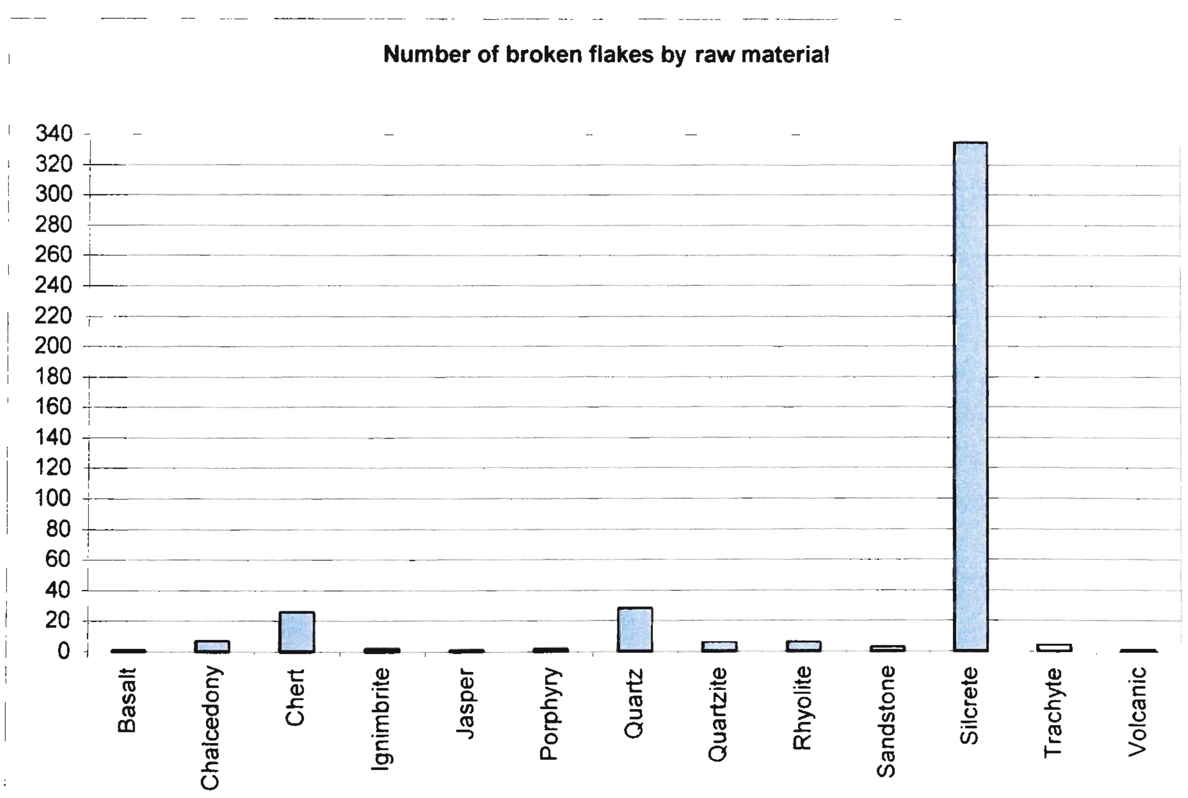

Figure 6.13 Number of broken flakes by raw material

Table 6.13 Average lengths of broken flakes by site

Site	Location	Count	Max. Length	Min. Length	Av. Length
BI02	West	7	38	20	29.4
BI03	West	22	59	7	33.1
BI04	East	1	31	31	31.0
BI09	East	98	54	6	25.7
BI11	West	11	49	14	28.8
BI13	East	13	70	13	35.5
BI16	East	77	52	5	23.1
BI19	East	3	24	14	20.7
BI20	East	1	31	31	31.0
BI21	East	13	41	16	26.1
BI22	East	2	45	21	33.0
BI30	East	64	55	4	20.5
BI31	East	2	20	12	16.0
BI33	East	8	52	13	22.4
BI35	East	18	54	10	24.3
BI36	East	5	24	8	16.4
BI37	East	2	38	36	37.0
BI39	East	2	25	20	22.5
BI41	West	8	33	9	21.3
BI42	West	1	14	14	14.0
BI48	West	1	47	47	47.0
BI49	West	4	28	2	19.3
BI55	West	1	10	10	10.0
BI67	West	2	37	35	36.0
BI68	East	16	65	12	29.0
BI73	West	30	68	10	28.1
BI74	West	5	46	12	26.4
BI85	East	2	29	14	21.5
BI89	East	3	31	19	25.7

Only 84 broken flakes (about 20%) exhibited cortex ranging from 5% to 50% and were from sites on both sides of the Island (Table 6.14). With the exception of two chert broken flakes from BI03 which exhibited geological cortex, all cortex recorded was of the cobble type.

From these broken flake results I infer that manufacturing was undertaken across the Island, although none of the predicted patterning is reflected.

Table 6.14 Broken flakes with cortex present

Site	Location	Cortex percentage	Number	Raw Material
BI02	West	20	1	Silcrete
BI02	West	50	1	Silcrete
BI03	West	10	3	Silcrete
BI03	West	10	1	Trachyte
BI03	West	25	1	Silcrete
BI03	West	50	1	Quartz
BI09	East	5	1	Chert
BI09	East	5	2	Silcrete
BI09	East	10	1	Quartz
BI09	East	10	1	Silcrete
BI09	East	20	1	Silcrete
BI09	East	25	3	Silcrete
BI09	East	30	3	Silcrete
BI09	East	40	3	Silcrete
BI09	East	50	1	Quartz
BI09	East	50	6	Silcrete
BI09	East	60	1	Silcrete
BI11	West	5	1	Silcrete
BI13	East	10	1	Chert
BI13	East	10	1	Jasper
BI16	East	5	5	Silcrete
BI16	East	10	5	Silcrete
BI16	East	40	1	Chert
BI16	East	50	1	Quartz
BI19	East	10	1	Silcrete
BI21	East	5	2	Silcrete
BI21	East	10	1	Chert
BI22	East	50	1	Silcrete
BI30	East	5	2	Silcrete
BI30	East	10	3	Silcrete
BI30	East	20	1	Silcrete
BI30	East	40	1	Silcrete
BI30	East	50	2	Silcrete
BI33	East	10	3	Silcrete
BI35	East	5	1	Silcrete
BI35	East	10	3	Silcrete
BI36	East	5	1	Silcrete
BI36	East	50	2	Silcrete
BI37	East	10	1	Chert
BI37	East	30	1	Silcrete
BI41	West	25	1	Chalcedony
BI42	West	10	1	Silcrete
BI68	East	10	1	Chert
BI68	East	15	1	Silcrete
BI68	East	50	1	Silcrete
BI73	West	5	1	Silcrete
BI73	West	10	1	Silcrete
BI73	West	20	1	Silcrete
BI73	West	25	2	Silcrete
BI74	West	40	1	Silcrete
BI85	East	25	1	Silcrete

FLAKED PIECES

Flaked pieces make up the most numerous technological category, with 768 artefacts found at 31 sites across the Island (Figure 6.14). As debitage they are indicative of artefact manufacture, but may also represent post-depositional breakage. Figure 6.15 shows the number at each site. The vast majority of flaked pieces occur on the eastern side of the Island. As with whole flakes, retouched flakes and broken flakes, silcrete was by far the most abundant raw material accounting for 471 flaked pieces (61%). One hundred and sixty two artefacts were of quartz, and 53 of chert. Figure 6.16 shows the numbers and types of raw materials.

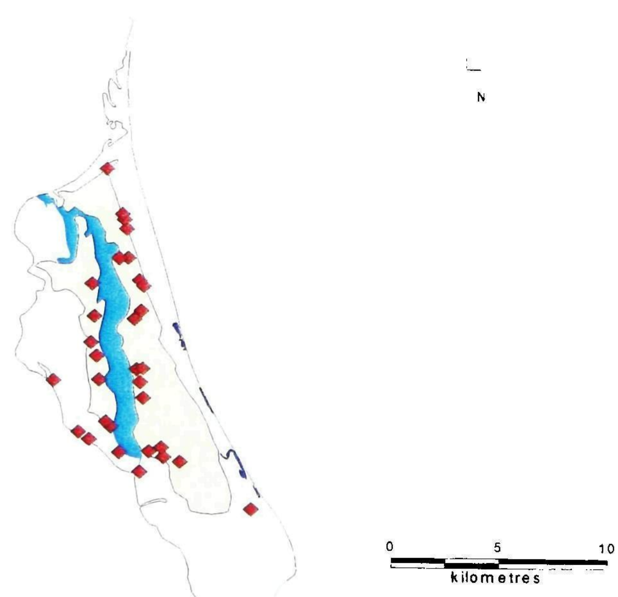

Figure 6.14 Distribution of flaked pieces

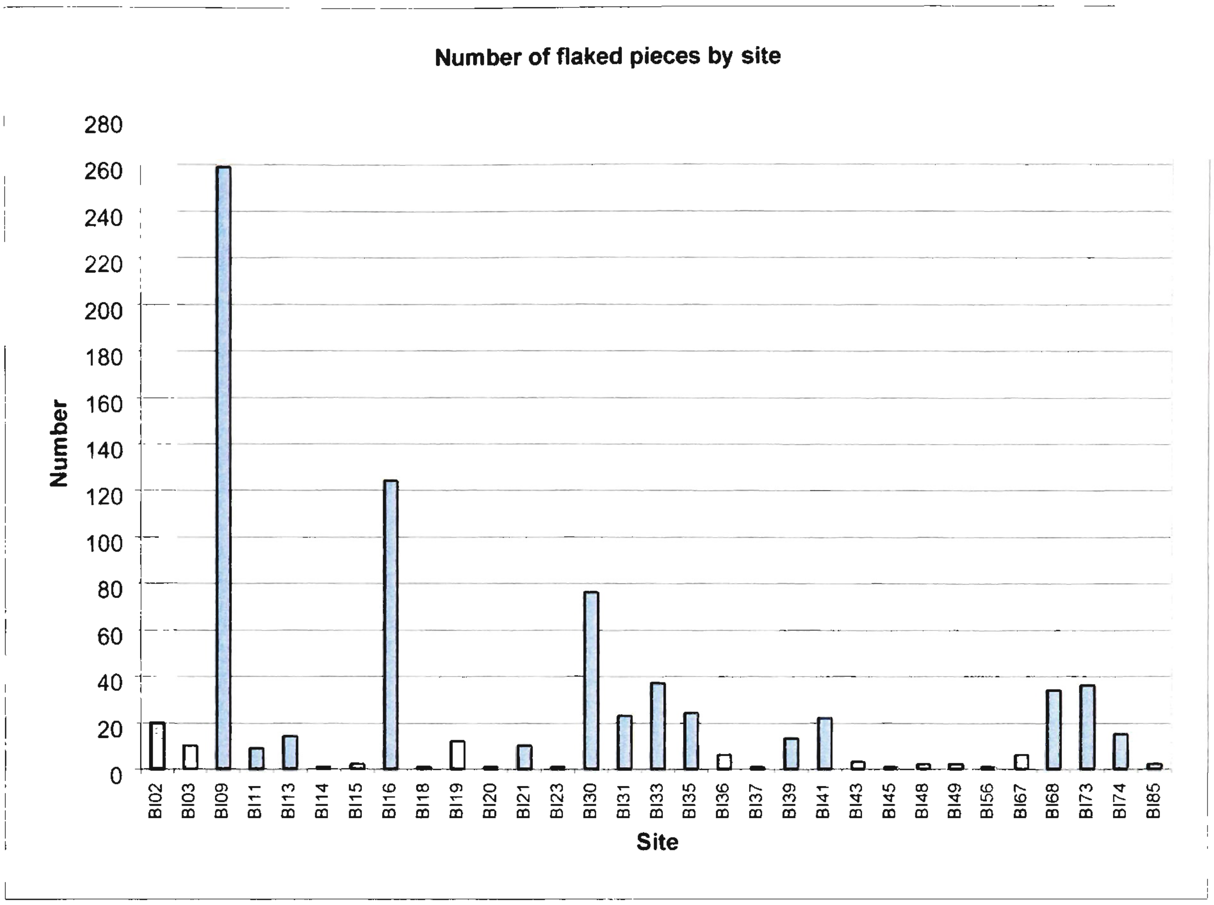

Figure 6.15 Number of flaked pieces by site

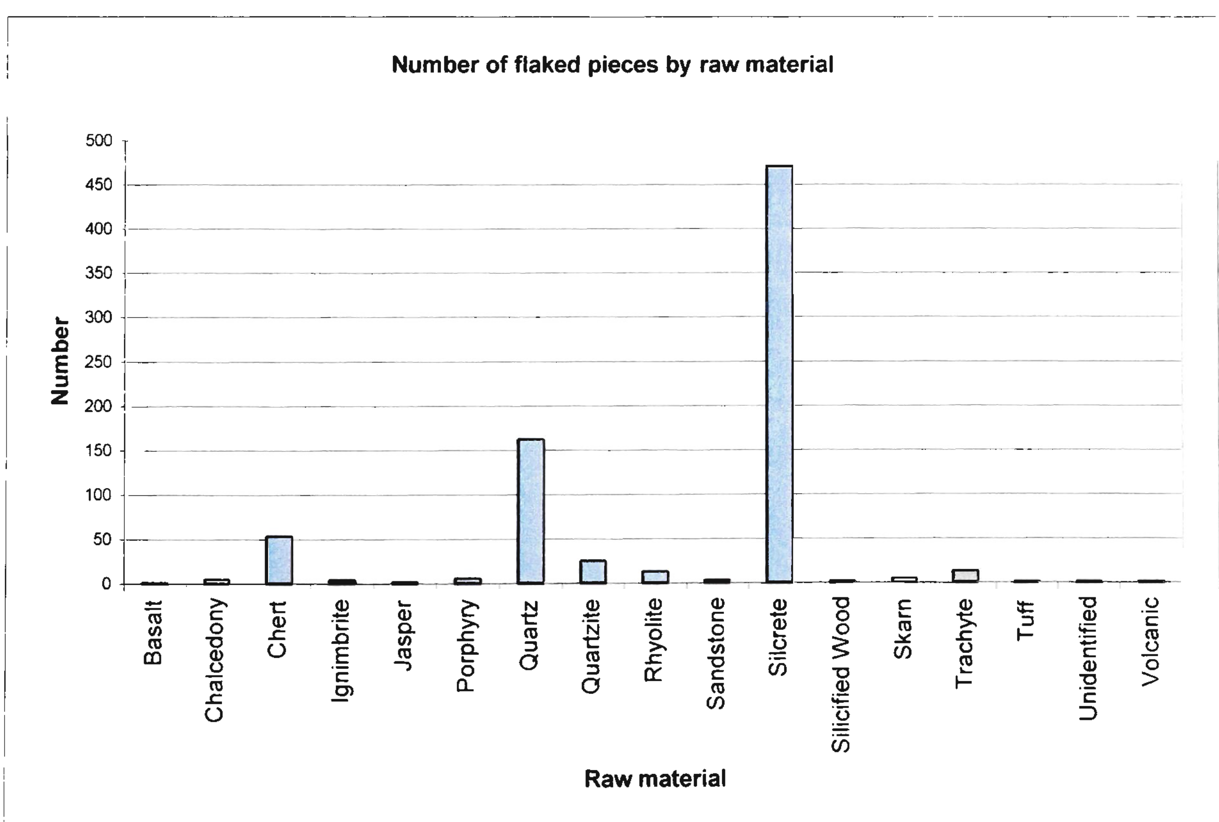

Figure 6.16 Number of flaked pieces by raw material

Table 6.15 Average weights and dimensions of flaked pieces

Site	Location	Number	Average Weight	Average Max. Dimension
BI02	West	20	5.9	28.3
BI03	West	10	19.4	40.0
BI09	East	259	1.7	13.7
BI11	West	9	10.5	36.8
BI13	East	14	4.4	27.5
BI14	East	1	0.1	10.0
BI15	East	2	1.1	18.5
BI16	East	124	1.9	17.4
BI18	East	1	1.8	28.0
BI19	East	12	2.2	24.7
BI20	East	1	0.1	11.0
BI21	East	10	3.5	27.3
BI23	East	1	0.3	13.0
BI30	East	76	2.4	17.7
BI31	East	23	1.6	18.0
BI33	East	37	2.5	19.2
BI35	East	24	3.2	22.5
BI36	East	6	2.1	19.8
BI37	East	1	11.6	45.0
BI39	East	13	0.7	12.4
BI41	West	22	2.3	20.1
BI43	West	3	5.6	26.7
BI45	West	1	22.8	47.0
BI48	West	2	1.6	18.0
BI49	West	2	7.3	39.5
BI56	West	1	1.1	18.0
BI67	West	6	11.7	31.0
BI68	East	34	3.5	23.1
BI73	West	36	6.2	25.3
BI74	West	15	5.3	25.2
BI85	East	2	0.9	12.0

Table 6.15 presents the average weights and maximum dimensions by site. Generally, the average weight is lower in sites on the eastern side of the Island. The distribution of average maximum dimensions appears far more random. Only ten of the flaked pieces exhibited cortex. Two chert flaked pieces from BI03 showed geological cortex, as did a silcrete flaked piece from BI21. Cobble type cortex was found on the other seven flaked pieces.

While not demonstrating any of the predicted variables, the flaked pieces show a trend of lower weights on the eastern side of the Island.

CORES

Cores (n=88) were found at 25 of the 43 sites (Figure 6.17). The number at each site is shown in Figure 6.18. Eleven raw materials were identified, the most common of which was silcrete (n=57, approximately 65% of the total). The next most frequent raw material was chert, represented by 14 cores (Figure 6.19).

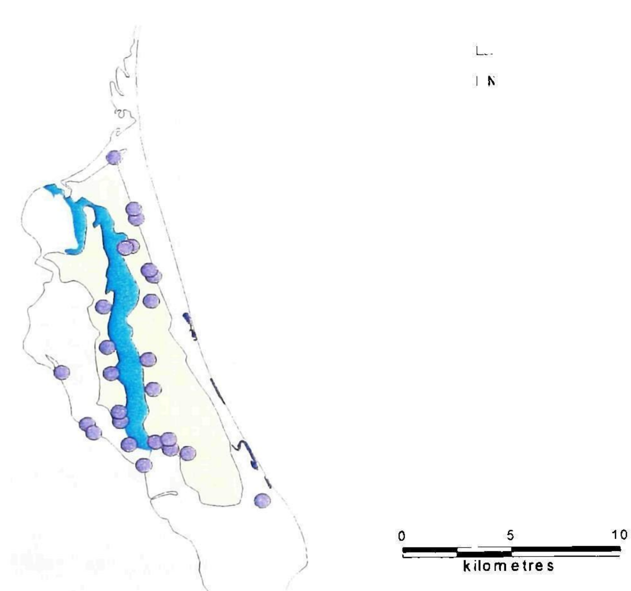

Figure 6.17 Distribution of cores

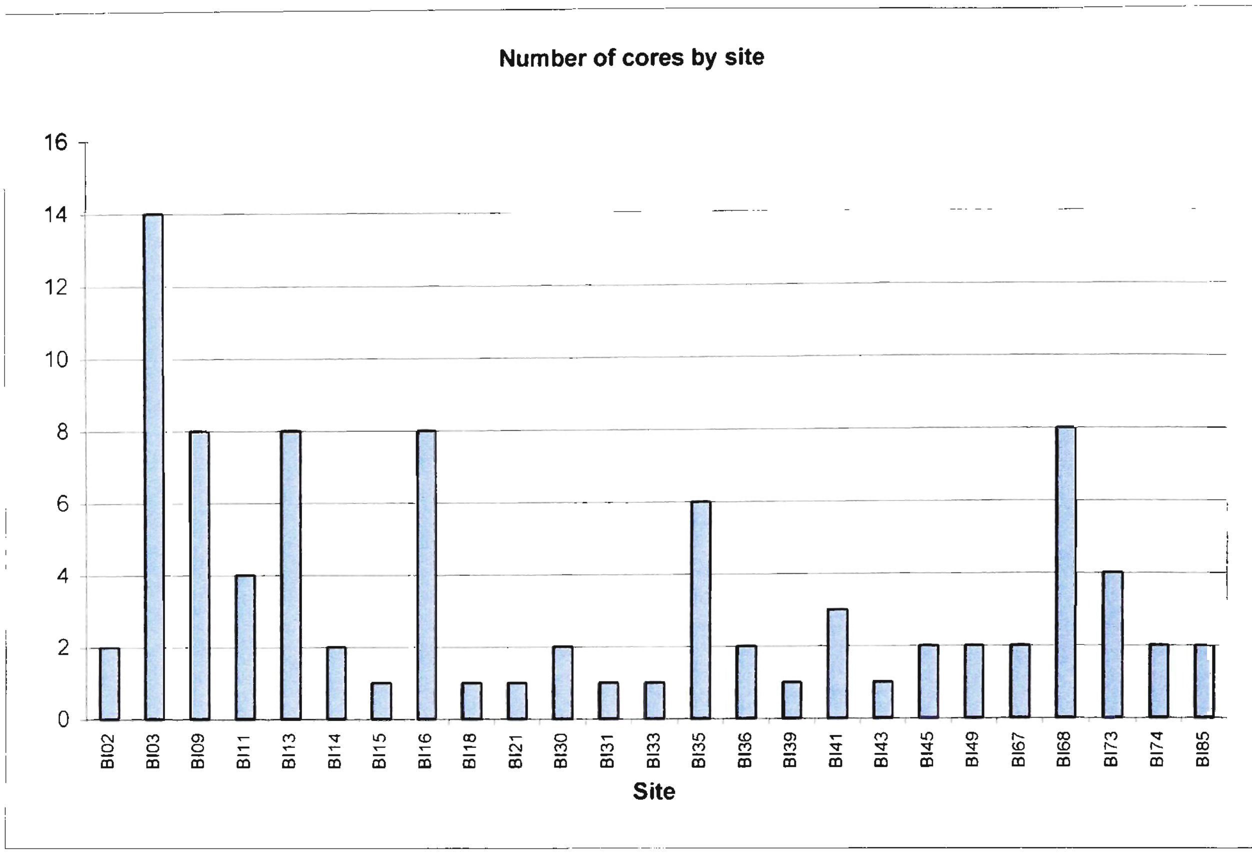

Figure 6.18 Number of cores by site

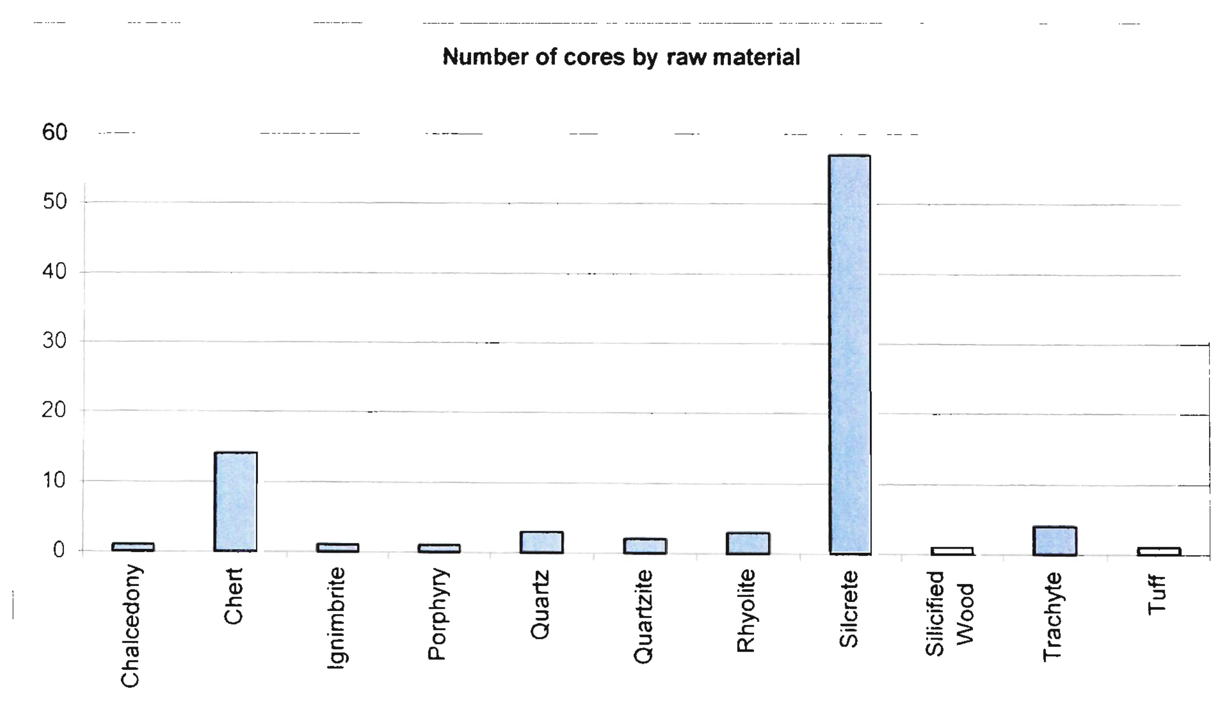

Figure 6.19 Number of cores by raw material

Table 6.16 shows the average length of the cores by site. Application of a standard *t* test revealed no statistically significant differences between core lengths and location ($p \geq 0.05$). Table 6.17 presents the maximum, minimum and average number of platforms by site. The presence of multiple platforms at all sites is indicative of widespread core rotation. This inference is consistent with multiple flake scars found on whole flakes (Table 6.9). Table 6.18 shows the maximum, minimum and average numbers of scars per core by site. There appears to be an overall trend of more scar numbers on the cores from the eastern side of the Island.

In Table 6.19 I show the average maximum core scar length and average minimum core scar length by site and location. Application of a standard *t* test revealed a statistically significant difference between the western and eastern average maximum scar length ($t=-2.244$, $df=86$, $p \leq 0.05$). An even greater statistically significant difference was revealed between west and east for average minimum scar length ($t= 2.813$, $df=86$, $p \leq 0.01$). This reflects the statistically significant differences for the average eastern and western whole flake lengths.

Twenty-two cores (25% of the total) from four sites on the western side of the Island and nine sites on the eastern side exhibited cortex ranging from 5% to 50% (Table 6.20). With the exception of a silcrete core from BI09 that had geological cortex present, all cortex recorded was of the cobble type.

Although the cores do not reflect the predicted patterning, there are significant east-west differences in certain attributes.

Table 6.16 Average length of cores by site

Site	Location	Number	Maximum Length	Minimum Length	Average Length
BI02	West	2	35	16	25.5
BI03	West	14	95	23	46.1
BI09	East	8	54	11	35.8
BI11	West	4	93	24	61.5
BI13	East	8	46	10	32
BI14	East	2	44	27	35.5
BI15	East	1	57	57	57.0
BI16	East	8	51	3	26.5
BI18	East	1	18	18	18.0
BI21	East	1	20	20	20.0
BI30	East	2	45	11	28.0
BI31	East	1	29	29	29.0
BI33	East	1	15	15	15.0
BI35	East	6	73	17	43.5
BI36	East	2	55	39	47.0
BI39	East	1	15	15	15.0
BI41	West	3	54	26	43.3
BI43	West	1	79	79	79.0
BI45	West	2	54	45	49.5
BI49	West	2	27	24	25.5
BI67	West	2	28	15	21.5
BI68	East	8	53	21	39.9
BI73	West	4	42	24	33.8
BI74	West	2	41	28	34.5
BI85	East	2	67	48	57.5

Table 6.17 Numbers of core platforms by site

Site	Location	Cores	Max. Plat. No.	Min. Plat No.	Average Plat. No.
BI02	West	2	2	2	2.0
BI03	West	14	3	1	2.2
BI09	East	8	4	1	2.0
BI11	West	4	2	2	2.0
BI13	East	8	2	1	1.4
BI14	East	2	2	1	1.5
BI15	East	1	2	2	2.0
BI16	East	8	3	1	1.8
BI18	East	1	2	2	2.0
BI21	East	1	2	2	2.0
BI30	East	2	2	1	1.5
BI31	East	1	2	2	2.0
BI33	East	1	2	2	2.0
BI35	East	6	2	1	1.5
BI36	East	2	2	1	1.5
BI39	East	1	2	2	2.0
BI41	West	3	3	1	1.7
BI43	West	1	3	3	3.0
BI45	West	2	3	2	2.5
BI49	West	2	2	1	1.5
BI67	West	2	1	1	1.0
BI68	East	8	4	1	2.0
BI73	West	4	2	1	1.5
BI74	West	2	1	1	1.0
BI85	East	2	2	1	1.5

Table 6.18 Core scar numbers by site

Site	Location	Cores	Max. Scar No	Min. Scar No	Average Scar no.
BI09	East	8	8	1	4.6
BI13	East	8	10	2	5.4
BI14	East	2	18	5	11.5
BI15	East	1	10	10	10.0
BI16	East	8	9	2	4.3
BI18	East	1	4	4	4.0
BI21	East	1	4	4	4.0
BI30	East	2	6	3	4.5
BI31	East	1	10	10	10.0
BI33	East	1	11	11	11.0
BI35	East	6	10	2	5.8
BI36	East	2	14	5	9.5
BI39	East	1	11	11	11.0
BI68	East	8	9	1	4.1
BI85	East	2	3	3	3.0
BI02	West	2	4	3	3.5
BI03	West	14	10	2	4.9
BI11	West	4	3	2	2.8
BI41	West	3	5	2	3.3
BI43	West	1	9	9	9.0
BI45	West	2	6	6	6.0
BI49	West	2	5	4	4.5
BI67	West	2	5	2	3.5
BI73	West	4	7	1	4.3
BI74	West	2	1	1	1.0

Table 6.19 Average maximum and minimum core scar length by site

Site	Location	Average maximum scar length	Average minimum scar length
BI09	East	29.4	15.1
BI13	East	28.3	13.8
BI14	East	26.5	14.0
BI15	East	31.0	18.0
BI16	East	23.5	14.0
BI18	East	18.0	12.0
BI21	East	20.0	12.0
BI30	East	17.5	9.0
BI31	East	25.0	10.0
BI33	East	17.0	7.0
BI35	East	27.5	15.3
BI36	East	34.0	6.0
BI39	East	12.0	5.0
BI68	East	35.6	17.6
BI85	East	26.0	11.5
BI02	West	25.0	16.0
BI03	West	35.7	16.7
BI11	West	39.3	20.5
BI41	West	39.7	18.3
BI43	West	43.0	24.0
BI45	West	31.5	15.0
BI49	West	23.0	9.5
BI67	West	21.0	13.0
BI73	West	32.3	20.5
BI74	West	27.0	27.0

Table 6.20 Core cortex percentages by site

Site	Location	Count	Cortex %	Raw Material
BI09	East	1	20	Silcrete
BI13	East	1	5	Silcrete
BI13	East	1	50	Silcrete
BI14	East	1	10	Silcrete
BI16	East	1	5	Silcrete
BI16	East	1	20	Silcrete
BI30	East	1	50	Silcrete
BI35	East	1	30	Silcrete
BI36	East	1	10	Silcrete
BI36	East	1	50	Silcrete
BI68	East	2	10	Silcrete
BI68	East	1	30	Chert
BI85	East	1	10	Silcrete
BI03	West	1	20	Chert
BI03	West	1	20	Silcrete
BI03	West	1	40	Silcrete
BI03	West	1	50	Silcrete
BI43	West	1	25	Silcrete
BI45	West	1	10	Chert
BI45	West	1	20	Silcrete
BI67	West	1	40	Silicified Wood

BEVELLED ARTEFACTS

Bevelled artefacts (n=30) make up the least numerous artefact category. The artefacts have a restricted distribution of 11 sites, eight on the western side of the central swale and three on the eastern side (Figure 6.20). The number at each site is shown in Figure 6.21. Eleven raw materials were identified, the most common being silcrete and ignimbrite (each n=7) followed by rhyolite (4) (Figure 6.22).

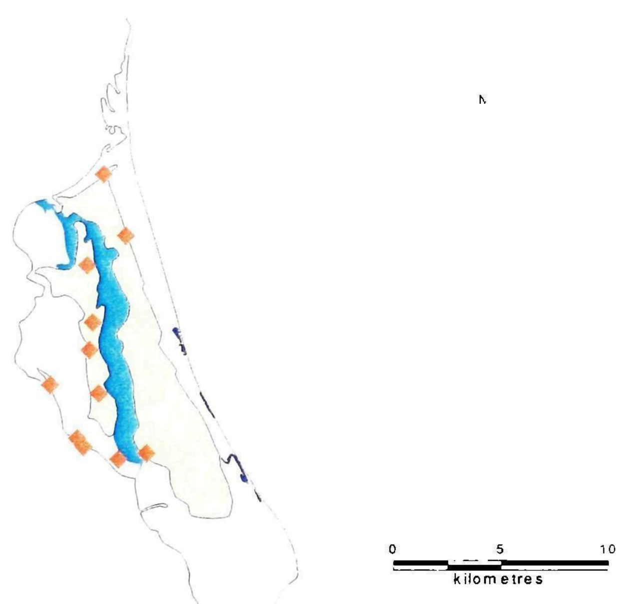

Figure 6.20 Distribution of bevelled artefacts.

Table 6.21 shows the maximum, minimum and average bevelled artefact lengths by site. Table 6.22 shows the maximum, minimum and average bevel widths by site. Three of the artefacts exhibit relatively wide bevels. Only eight of the bevelled artefacts were unbroken. One of the artefacts exhibited evidence of bipolar manufacture, and one bevelled artefact from BI03 exhibited 20% cortex.

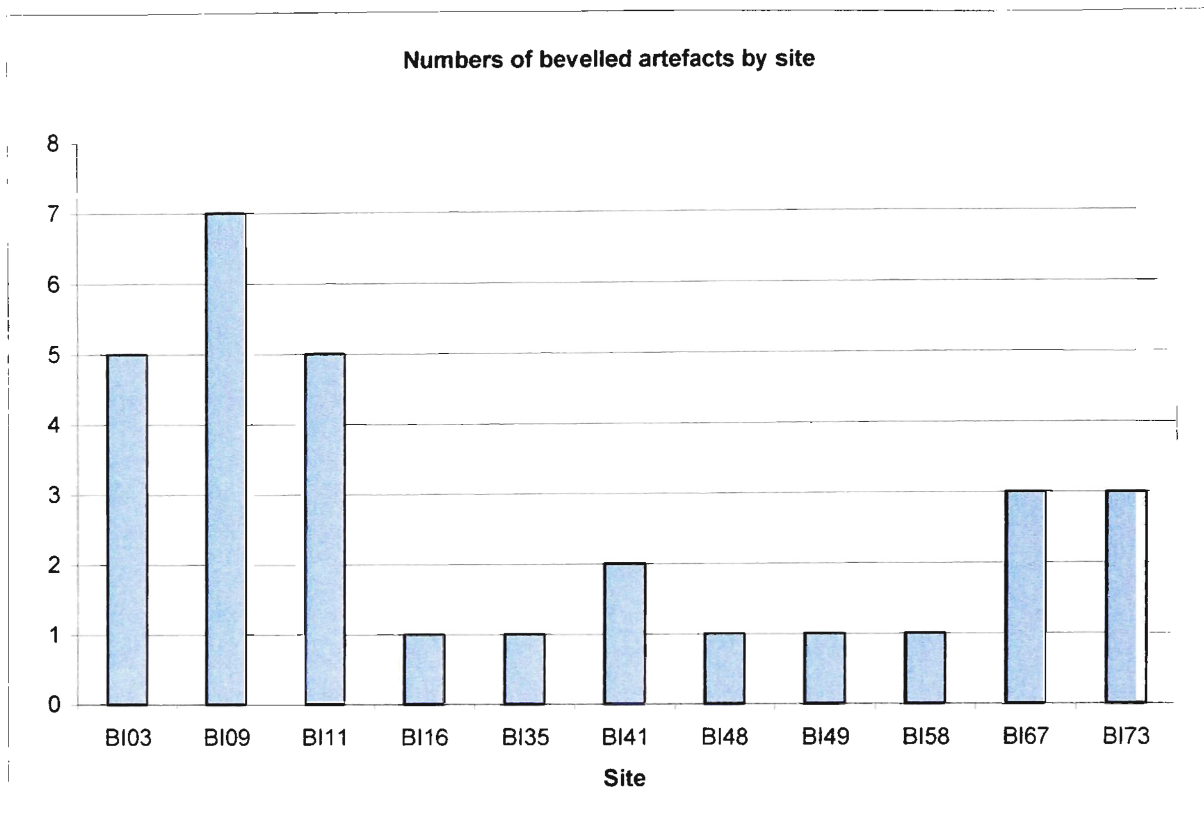

Figure 6.21 Number of bevelled artefacts by site

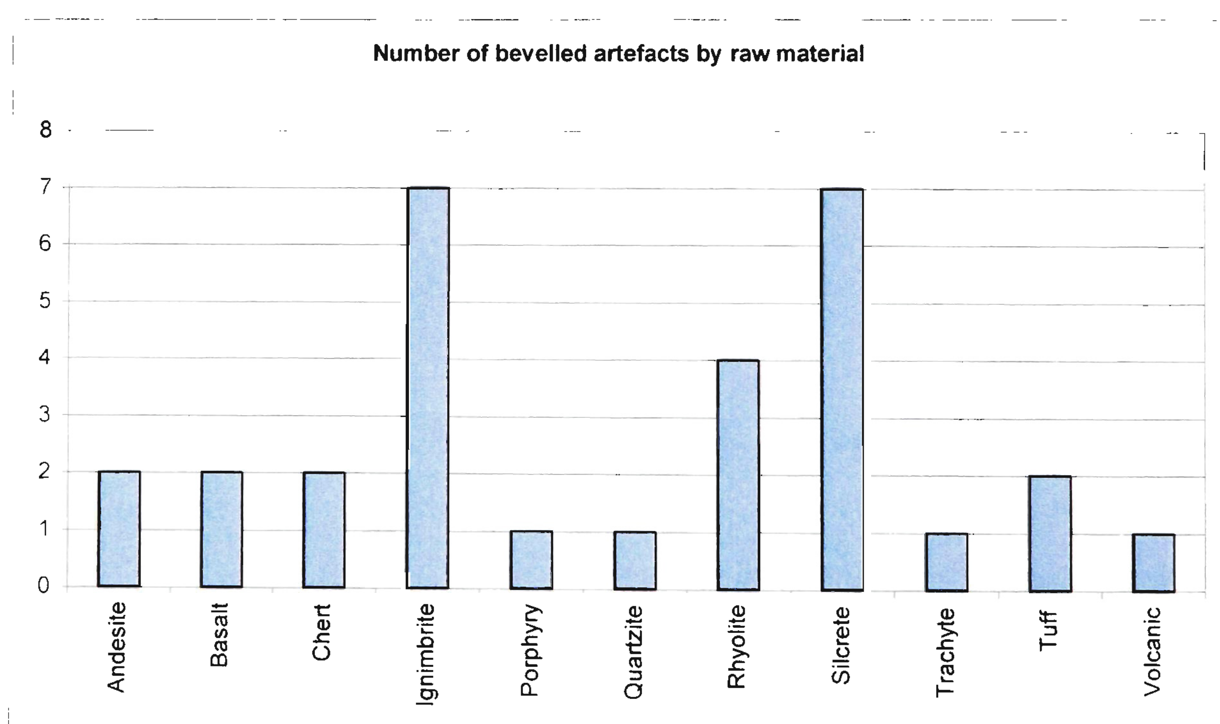

Figure 6.22 Number of bevelled artefacts by raw material

Table 6.21 Lengths of bevelled artefacts by site

Site	Location	Number	Maximum Length	Minimum Length	Average Length
BI03	West	5	83	32	67.2
BI09	East	7	141	19	83.7
BI11	West	5	110	39	63.6
BI16	East	1	21	21	21.0
BI35	East	1	26	26	26.0
BI41	West	2	54	36	45.0
BI48	West	1	103	103	103.0
BI49	West	1	127	127	127.0
BI58	West	1	136	136	136.0
BI67	West	3	101	71	88.0
BI73	West	3	127	30	73.0

Table 6.22 Bevel widths by site

Site	Location	Number	Max.Bevel width	Min.Bevel width	Avg.Bevel width
BI03	West	5	12.00	2.00	6.4
BI09	East	7	9.00	2.00	6.1
BI11	West	5	17.00	4.00	7.4
BI16	East	1	8.00	8.00	8.0
BI35	East	1	6.00	6.00	6.0
BI41	West	2	5.00	4.00	4.5
BI48	West	1	1.00	1.00	1.0
BI49	West	1	10.00	10.00	10.0
BI58	West	1	2.00	2.00	2.0
BI67	West	3	8.00	4.00	5.3
BI73	West	3	8.00	4.00	5.3

OTHER ARTEFACTS

Sixty-eight other artefacts, i.e. those that exhibit no evidence of flaking but do exhibit evidence of grinding, abrading or pitting, were found at 19 of the 43 sites (Figure 6.23). Figure 6.24 gives the frequency of artefacts at each site. Thirteen raw materials were identified, the most common being sandstone accounting for 28 artefacts (Figure 6.25). Table 6.23 shows the maximum, minimum and average weights by site. To foster a clear understanding of the nature of my 'other artefacts', I have provided descriptions of them in Table 6.24.

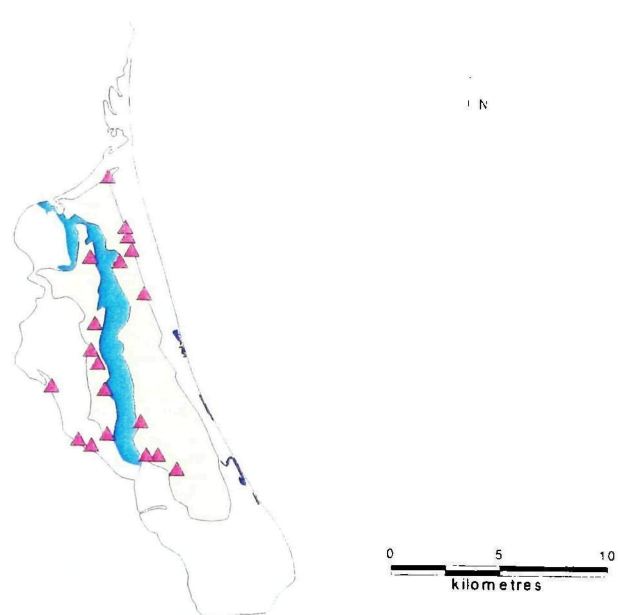

Figure 6.23 Distribution of other artefacts.

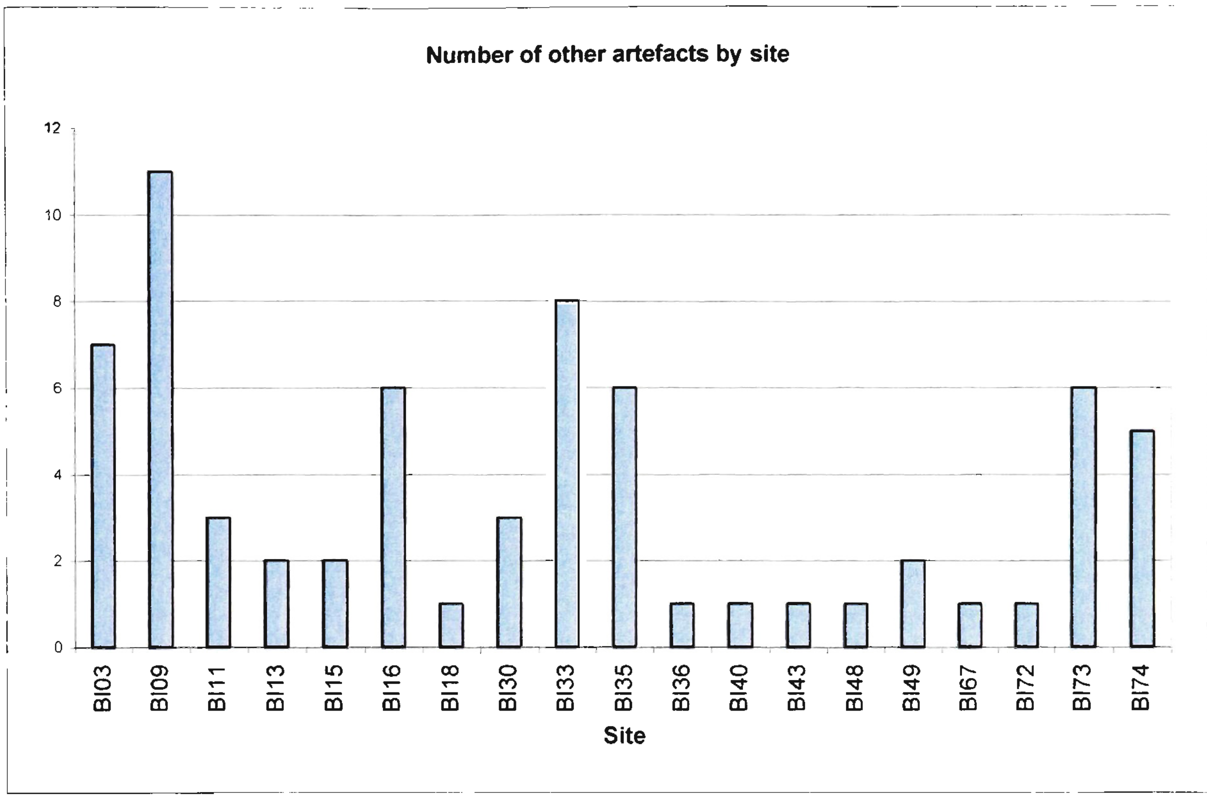

Figure 6.24 Number of other artefacts by site

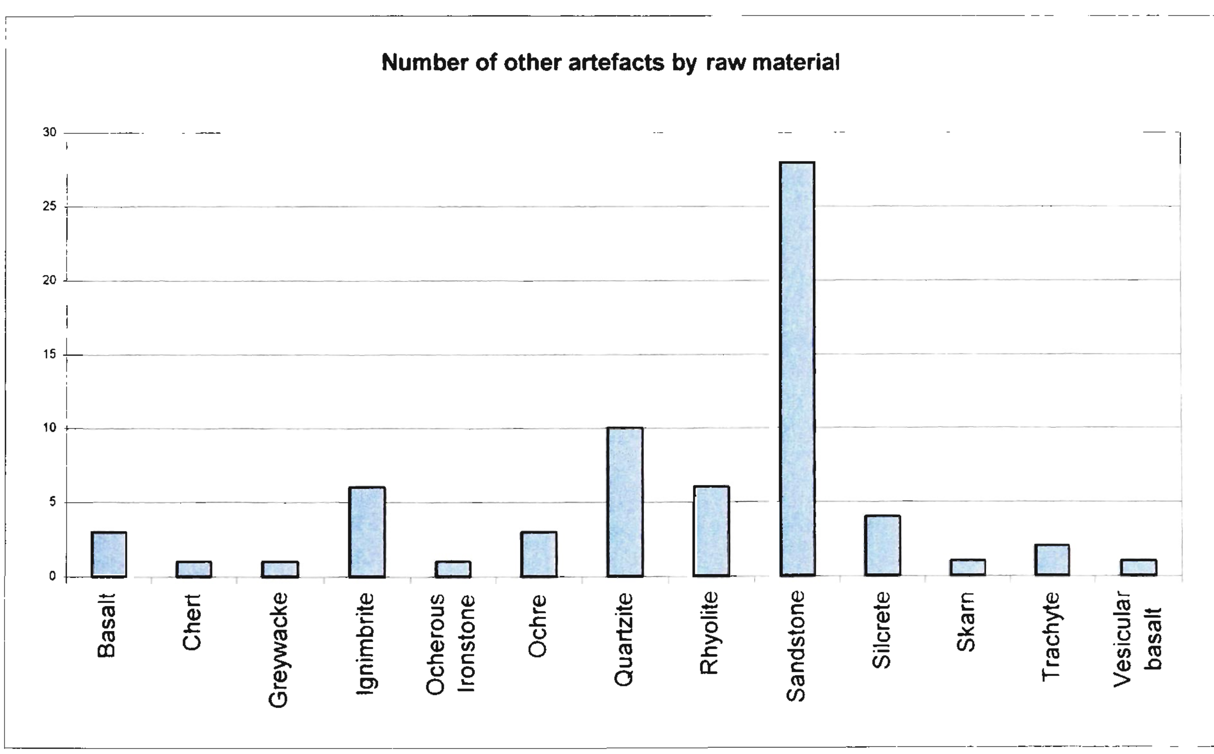

Figure 6.25 Number of other artefacts by raw material

Table 6.23 Average weight of other artefacts by site

Site	Location	Number	Max. Weight	Min. Weight	Avg. Weight
BI03	West	7	618.9	97.6	312.5
BI09	East	11	804.5	13.6	150.6
BI11	West	3	460.5	10.9	192.9
BI13	East	2	1608.9	80.9	844.9
BI15	East	2	57.7	20	38.9
BI16	East	6	756.3	3.5	201.4
BI18	East	1	28.4	28.4	28.4
BI30	East	3	48.1	3.4	24.9
BI33	East	8	118	2.1	26.2
BI35	East	6	2715	58	1038.0
BI36	East	1	247.7	247.7	247.7
BI40	East	1	5740	5740	5740.0
BI43	West	1	42.4	42.4	42.4
BI48	West	1	75.1	75.1	75.1
BI49	West	2	54.4	33.8	44.1
BI67	West	1	639.2	639.2	639.2
BI72	West	1	27.4	27.4	27.4
BI73	West	5	570	3.9	190.7
BI74	West	5	420	14	114.1

Table 6.24 Other artefacts description

Artefact	Site	Raw Material	Weight	Description
OA11/1	BI11	Skarn	107.2	Fragment with ground body and edge
OA11/2	BI11	Vesicular basalt	460.5	Ground body
OA13/1	BI13	Sandstone	80.9	Split cobble with abraded surface
OA13/2	BI13	Sandstone	1608.9	Ground surface
OA15/1	BI15	Quartzite	57.7	Ground surfaces; broken
OA15/2	BI15	Ignimbrite	20	Ground surface; ?broken BP
OA16/1	BI16	Ocherous Ironstone	34.4	One ground surface
OA16/2	BI16	Sandstone	8.3	Fragment with ground edge
OA16/3	BI16	Rhyolite	3.5	Ground, with ?ochre stain
OA16/4	BI16	Rhyolite	114.6	Fragment with ground edge
OA16/5	BI16	Ignimbrite	291.3	Ground edge
OA16/6	BI16	Silcrete	756.3	Two ground surfaces and rounded margin. Edge damage one margin. Broken.
OA18/1	BI18	Basalt	28.4	Two ground surfaces; fragment
OA3/1	BI03	Ignimbrite	476.5	Four ground surfaces and two bevels
OA3/2	BI03	Quartzite	618.9	Ground one surface
OA3/3	BI03	Ignimbrite	161.5	Ground surface; ?BP fragment
OA3/4	BI03	Trachyte	97.6	Broken; one ground surface
OA3/5	BI03	Quartzite	183.5	Broken; one margin ground
OA3/6	BI03	Sandstone	397.9	Flattish broken ovoid; ground margin and surface
OA3/7	BI03	Sandstone	251.5	Round-flattish; one margin ground
OA30/1	BI30	Trachyte	23.1	Heavily weathered, possibly rhyodacitic porphyry. Ground margin and one ground surface. Broken.
OA30/2	BI30	Sandstone	3.4	Abraded fragment
OA30/3	BI30	Sandstone	48.1	Abraded fragment
OA33/1	BI33	Ochre	13.5	Pebble with ground surface
OA33/2	BI33	Sandstone	21.6	Fragment with bevelled edge and three abraded surfaces
OA33/3	BI33	Sandstone	32.2	Fragment with abraded surface
OA33/4	BI33	Sandstone	7.5	Curved fragment with two abraded surfaces
OA33/5	BI33	Sandstone	9	Fragment with abraded surface
OA33/6	BI33	Sandstone	5.7	Fragment with abraded surface
OA33/7	BI33	Sandstone	2.1	Fragment with abraded surface
OA33/8	BI33	Sandstone	118	Curved abraded surface
OA35/1	BI35	Greywacke	148.1	Fragment of ground stone
OA35/2	BI35	Quartzite	1233.5	Ground edge
OA35/3	BI35	Sandstone	1039.8	Ground stone fragment
OA35/4	BI35	Sandstone	2715	Ground stone fragment
OA35/5	BI35	Ignimbrite	1033.6	Two conjoining pieces of ground stone
OA35/6	BI35	Sandstone	58	Fragment of ground stone
OA36/1	BI36	Rhyolite	247.7	Angular ground piece with two ground surfaces

Table 6.24 (continued)

OA40/1	BI40	Quartzite	5740	Massive elliptical rock with abraded circular depressions on obverse and reverse.
OA43/1	BI43	Silcrete	42.4	Rounded, ground fragment. Field recording
OA48/1	BI48	Quartzite	75.1	Fragment ground stone
OA49/1	BI49	Quartzite	54.4	Broken, shaped like a pear quarter with bottom abraded
OA49/2	BI49	Sandstone	33.8	Fragment with abraded surface
OA67/1	BI67	Silcrete	639.2	Rhomboid split cobble with three ground surfaces and ? one bevelled edge
OA72/1	BI72	Ochre	27.4	One ground surface
OA73/1	BI73	Sandstone	14.9	Rounded ground fragment
OA73/2	BI73	Sandstone	114.7	Rounded ground fragment
OA73/3	BI73	Ignimbrite	570	Large angular fragment with ground surface
OA73/4	BI73	Sandstone	250	Fragment with ground edge
OA73/5	BI73	Ochre	3.9	Ground all margins
OA73/6	BI73	Rhyolite	225	Ground edges one margin
OA74/1	BI74	Quartzite	79	Curved surface ground on one edge
OA74/2	BI74	Sandstone	420	Curved ground artefact
OA74/3	BI74	Sandstone	38	Fragment
OA74/4	BI74	Silcrete	19.7	Curved fragment
OA74/5	BI74	Chert	14	Fragment
OA9/1	BI09	Sandstone	58.1	Tear-drop shaped fragment with flat cleavage plane on one side; opposite side and margins abraded and rounded
OA9/10	BI09	Quartzite	63.2	Ground fragment
OA9/11	BI09	Quartzite	804.5	Massive fragment with ground edge.
OA9/2	BI09	Rhyolite	25.7	Fragment; abraded margin and finely ground rounded end.
OA9/3	BI09	Basalt	52.3	Fragment with finely ground/ polished area on margin and ground/polished area on one surface.
OA9/4	BI09	Sandstone	24.5	Fragment of ground stone
OA9/5	BI09	Rhyolite	273.9	Broken; rounded ground artefact with bevel on one margin. FS6
OA9/6	BI09	Sandstone	26	Fragment of ground artefact.
OA9/7	BI09	Rhyolite	265.6	Broken; one ground surface. ?part of BP
OA9/8	BI09	Sandstone	48.8	Ground fragment
OA9/9	BI09	Sandstone	13.6	Ground fragment

MANUPORTS

A total of 437 manuports were found at 28 of the 43 study sites (Figure 6.26). The most common of the 27 identified raw materials was ocherous ironstone, accounting for 123 manuports. Figure 6.27 shows the manuport frequency at each site, and Figure 6.28 shows the frequency by raw material. In Table 6.25 I show the maximum, minimum and average weights of the manuports by site. Application of a standard *t* test indicated a higher mean weight for manuports on the eastern side of the Island (t= -2.3383, df = 26, p≤0.05), but no pattern in terms of the putative import points.

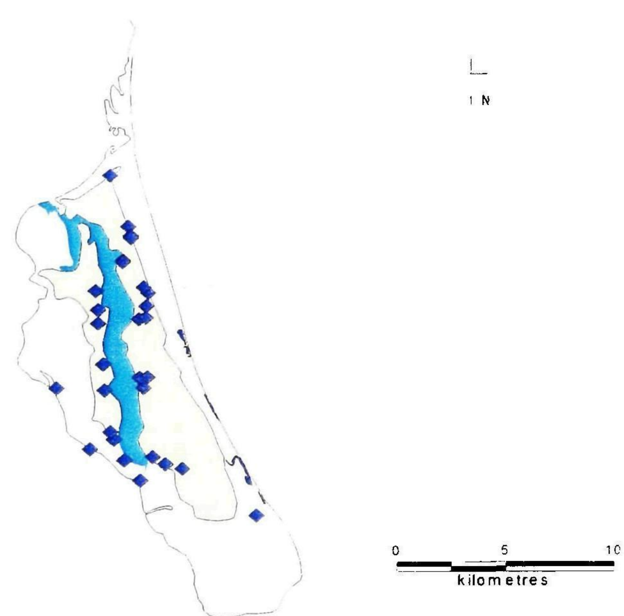

Figure 6.26 Distribution of manuports

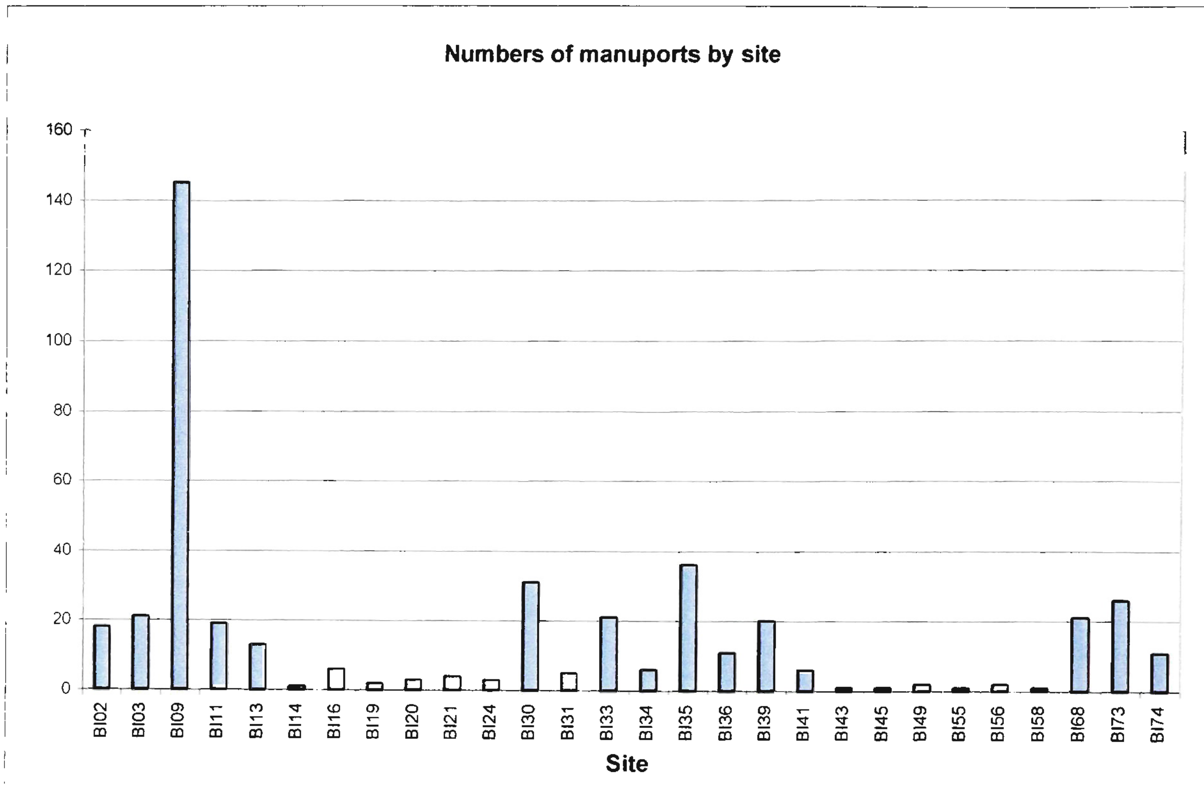

Figure 6.27 Number of manuports by site

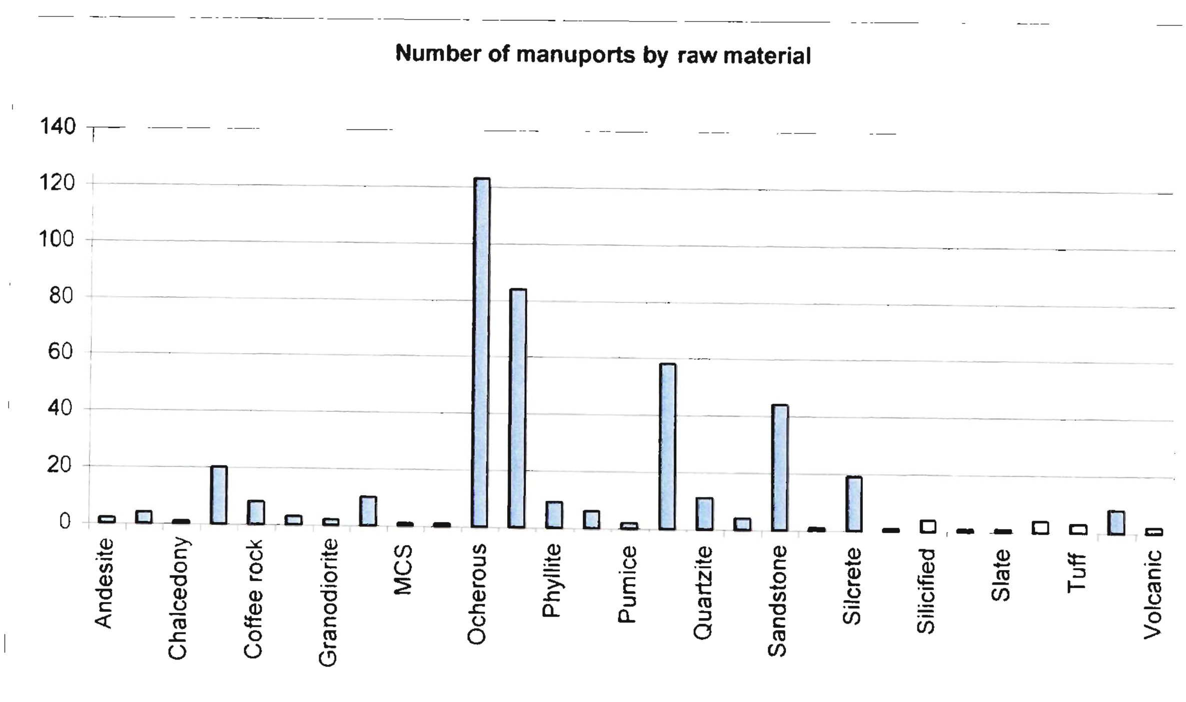

Figure 6.28 Number of manuports by raw material

Table 6.25 Manuport weights by site

Site	Location	Number	Max. Weight	Min. Weight	Avg. Weight
BI02	West	18	851.80	0.30	58.0
BI03	West	21	216.40	1.10	56.4
BI09	East	145	6000.00	0.05	57.1
BI11	West	19	594.10	1.70	100.2
BI13	East	13	61.70	0.20	15.0
BI14	East	1	64.10	64.10	64.1
BI16	East	6	30.60	0.30	7.5
BI19	East	2	1.10	0.30	0.7
BI20	East	3	6.20	0.30	2.6
BI21	East	4	7.30	1.90	4.5
BI24	East	3	1.70	0.60	1.0
BI30	East	31	272.00	0.20	11.4
BI31	East	5	22.90	1.20	7.5
BI33	East	21	23.20	0.40	5.1
BI34	East	6	3.20	1.10	2.2
BI35	East	36	98.20	0.20	13.8
BI36	East	11	17.60	2.10	9.5
BI39	East	20	109.80	0.70	11.2
BI41	West	6	73.00	3.60	32.7
BI43	West	1	9.00	9.00	9.0
BI45	West	1	3.20	3.20	3.2
BI49	West	2	158.60	10.90	84.8
BI55	West	1	37.40	37.40	37.4
BI56	West	2	49.20	4.00	26.6
BI58	West	1	5.70	5.70	5.7
BI68	East	21	465.60	0.20	29.9
BI73	West	26	172.80	0.80	22.2
BI74	West	11	58.30	1.80	14.7

RAW MATERIALS

Raw material was identified for all but ten of the artefacts analysed. The most abundant raw material was silcrete, which accounted for 1136 artefacts or 53.25% of the assemblage. The second most frequent raw material was quartz, with 266 artefacts (12.42%), followed by chert with 142 artefacts (6.65%) and then 124 ocherous ironstone artefacts (5.8%) (Figure 6.29)

Raw material types

With a couple of exceptions the raw materials fall into two main categories: fine grained siliceous material, and fine grained volcanic material. The most common raw material present is silcrete.

Silcrete is well recognised in Australia as both a rock in its own right and as a raw material, but is less so in North America and Europe. Even in Australia, silcrete is often described as quartzite (and vice versa) as the two closely resemble each other macroscopically, but their formation processes and mineral content are very different. Silcrete in Australia has been the topic of an entire volume in the discipline of geology (Langford-Smith 1978), therefore only a brief review is contained here. Quartzite is a metamorphic rock, the result of 'low-grade metamorphism of a quartz sandstone. No new minerals are formed during metamorphism. The quartz grains are simply welded into a hard, compact, and denser quartz rock. No cleavage or schistosity is apparent' (Mayer1976: 272).

Silcrete, on the other hand, is the result of lateritic processes whereby kaolinite is lost and silica is accumulated (Lapidus and Winstanley 1990). Although silcrete has been

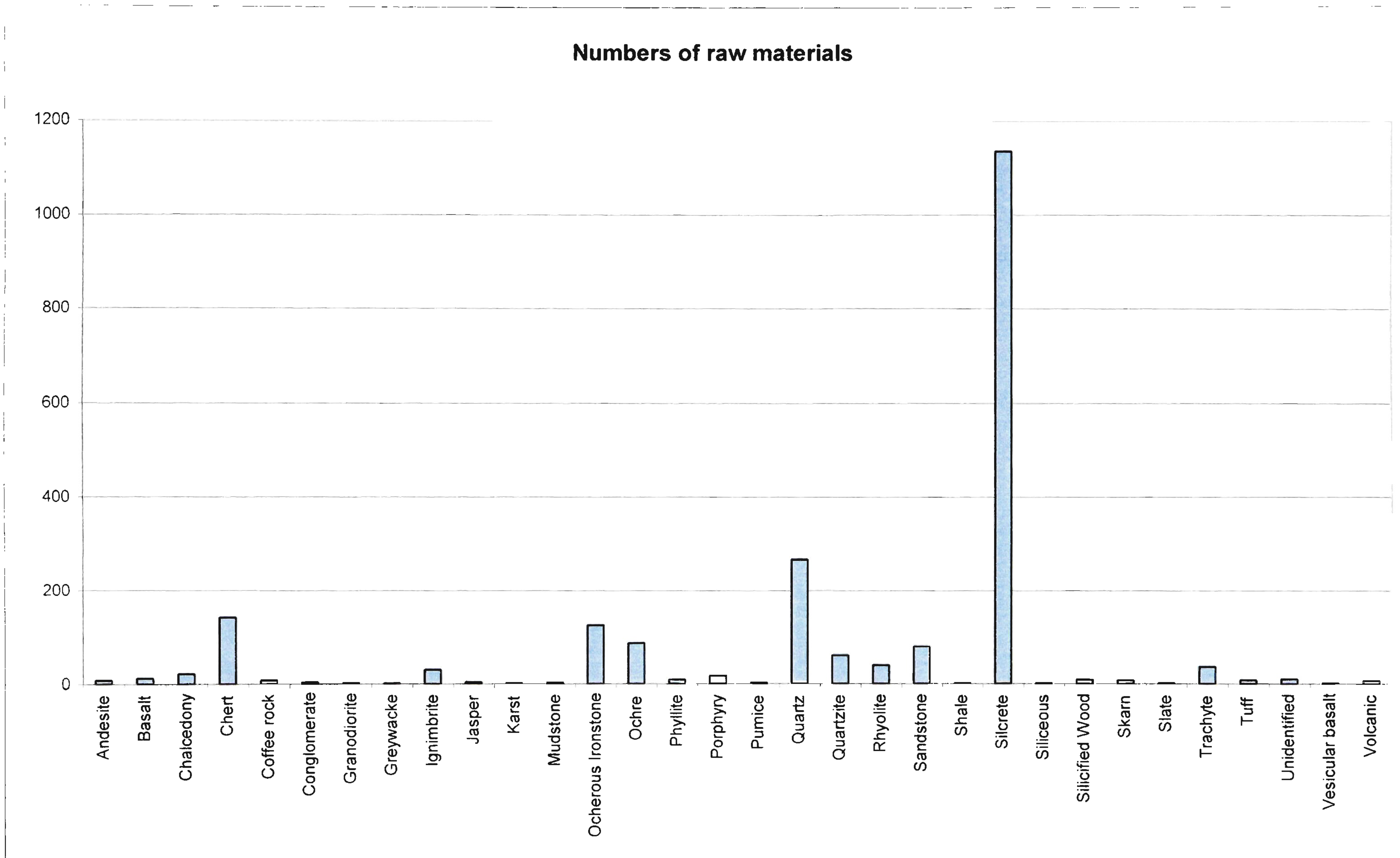

Figure 6.29 Numbers of raw materials

found beneath and in close association with basalt, there is no genetic (*sic*) connection (Ollier 1978:14). More commonly, silcrete is associated with chemically weathered sedimentary deposits; this 'true' silcrete is comparatively rare. The silcrete referred to in this study may in strict petrologic terms be quartzite, but differentiated from other quartzites present by grain size. This use of the terms 'silcrete and 'quartzite' has historically been used by archaeologists (although not always by geologists) in describing artefacts from southeast Queensland. It is widely understood and accepted in archaeological literature to have the meaning I have presented here. As my study is in a comparable southeast Queensland archaeological context, I have no problems with the use of both silcrete and quartzite to describe the raw materials.

It is clear from the discussions of the artefact categories that the raw materials are distributed throughout almost all of the sites. Thirty-six of the sites contain multiple raw materials. Table 6.26 shows the raw materials present at each site. The distribution appears random, with perhaps the exception of quartz that seems to cluster on the eastern side. Table 6.27 lists the raw materials and the technological categories in which they occur; some raw materials such as ocherous ironstone and ochre appear to be category-specific.

Table 6.26 Raw materials present at each site

Site	Andesite	Basalt	Chalcedony	Chert	Coffee Rock	Conglomerate	Granodiorite	Greywacke	Ignimbrite	Jasper	MCS	Mudstone	Ocherous	Ochre	Phyllite	Porphyry	Pumice	Quartz	Quartzite	Rhyolite	Sandstone	Shale	Silcrete	Silicified Wood	Skarn	Slate	Trachyte	Tuff	Unidentified	Vesicular basalt	Volcanic
BI02				X					X					X				X	X		X		X	X			X				
BI03				X					X			X		X				X	X	X	X		X	X			X	X	X		
BI04																							X								
BI09		X		X	X				X				X	X	X	X		X	X	X	X	X	X			X	X	X	X		X
BI11	X	X		X		X			X					X				X	X	X	X		X	X	X		X			X	
BI13			X	X						X				X	X			X	X		X		X	X					X		
BI14													X										X								
BI15									X										X				X				X				
BI16			X	X					X				X	X				X		X	X		X	X			X				
BI18		X	X																X	X			X								
BI19										X							X		X				X								
BI20													X										X								
BI21				X									X					X					X	X							
BI22				X																			X								
BI23																		X													
BI24													X					X													
BI30			X	X								X	X	X	X	X		X	X	X	X		X				X		X		X
BI31				X									X	X				X	X		X		X								
BI33			X	X					X	X			X	X				X	X		X		X				X		X		
BI34													X					X			X										
BI35			X	X			X	X	X		X		X	X			X	X	X	X	X		X				X				
BI36	X			X			X						X	X				X		X	X		X				X				
BI37				X																			X								
BI39		X		X					X				X	X	X			X			X		X								
BI40																			X												

Site	Andesite	Basalt	Chalcedony	Chert	Coffee Rock	Conglomerate	Granodiorite	Greywacke	Ignimbrite	Jasper	MCS	Mudstone	Ocherous	Ochre	Phyllite	Porphyry	Pumice	Quartz	Quartzite	Rhyolite	Sandstone	Shale	Silcrete	Silicified Wood	Skarn	Slate	Trachyte	Tuff	Unidentified	Vesicular basalt	Volcanic
BI41	X		X	X					X				X					X	X	X			X		X			X			
BI42																							X								
BI43													X					X	X				X				X				
BI45				X									X										X								
BI48				X														X	X	X			X								
BI49				X									X					X	X		X		X								X
BI55				X									X																		
BI56													X										X								
BI58									X				X																		
BI63																							X								
BI67	X			X														X		X			X	X							
BI68			X	X									X		X			X	X				X				X				
BI72														X																	
BI73				X					X				X	X				X		X	X		X				X	X			
BI74				X									X	X				X	X		X		X				X				
BI83																							X								
BI85			X															X					X								
BI89																							X								

Table 6.27 Raw materials and technological categories

Raw material	Whole Flake	Retouch Flake	Broken Flake	Flaked Piece	Core	Bevelled Artefact	Other Artefact	Manuport
Andesite	X	X				X		X
Basalt	X		X	X		X	X	X
Chalcedony	X	X	X	X	X			X
Chert	X	X	X	X	X	X	X	X
Coffee Rock								X
Conglomerate								X
Granodiorite								X
Greywacke							X	
Ignimbrite			X	X	X	X	X	X
Jasper			X	X				
MCS								X
Mudstone	X							X
Ocherous Ironstone							X	X
Ochre							X	X
Phyllite								X
Porphyry	X		X	X	X	X		X
Pumice								X
Quartz	X	X	X	X	X			X
Quartzite	X		X	X	X	X	X	X
Rhyolite	X	X	X	X	X	X	X	X
Sandstone	X		X	X			X	X
Shale								X
Silcrete	X	X	X	X	X	X	X	X
Silicified Wood	X			X	X			X
Skarn	X			X			X	X
Slate								X
Trachyte	X		X	X	X	X	X	X
Tuff				X	X	X		X
Unidentified	X			X				X
Vesicular Basalt							X	
Volcanic	X		X	X		X		X

SUMMARY

My analysis revealed that there is no correlation at all between artefact size and distance from the hypothesised import points BI09 and BI67. There are however statistically significant differences in the average length of whole flakes from the eastern and western sides of the Island. These differences are also reflected in the lengths of flake scars on the cores. Manuports on the eastern side of the Island have a higher mean weight than on the western side. Other trends identified also suggest west-east differences in certain artefact attributes. Silcrete is by far the most common raw material, but a variety of raw materials are found all over the study area; some of them appear to be technological category specific. Cortex appears on artefacts from all over the Island. In sum, the results are not as were predicted. Explanations for the absence of the expected patterning and the implications of the east-west differences are presented in the following discussion chapter.

CHAPTER SEVEN DISCUSSION AND CONCLUSION

The aim of this thesis has been to test a hypothetical model of Aboriginal settlement on Bribie Island which posited movement over the island north-south along the remnant Pleistocene dune system, with limited west-east movement where swamps did not present a barrier. It also posited that groups coalesced and dispersed in response to varying stimuli and that the large sites, BI09 and BI67, were semi-permanent residential areas as well as import points for stone. Based on the predictive model and literature I made assumptions about the spatial patterning of artefacts and raw materials on Bribie Island. I employed a technological analysis of the stone artefact assemblage to test those assumptions. While the results of the analysis did not support the import point model, statistically significant differences were found between certain flake and core attributes on the eastern and western sides of the swamp.

The discussion now focuses on the implications of those results and explores why the predicted variations were not found.

The research questions and the import point model

In Chapter One I introduced my research questions:

- Does raw material usage on Bribie Island exhibit patterns of spatial variation?
- Do stone artefacts on Bribie Island exhibit spatial variation in size, artefact categories or in the proportion of both size and artefact category?
- Is the hypothesis of import sites supported? If not, how can the pattern of sites on the Island be explained?

The expectations from Chapter One were that there would be morphological differences in the artefacts, variations in assemblage composition and variations in raw material use as distance from the hypothesised import points increased. The assumptions about the Bribie Island artefact assemblage were not proven by my analysis. The raw materials in the assemblage are reliable, and spread throughout the Island. There was no correlation between artefact size and distance from the inferred import points, sites BI09 and BI67. Variations in artefact categories did not significantly differ at increased distances from BI09 and BI67. However there were spatial variations in whole flake length, core scar length and manuport weight between the western and eastern sides of the Island.

Why didn't the model work?

The resource rich subtropical environment of Bribie Island is very different from the semi-arid or arid environments in which some of the rationing or distance-decay models have been successfully demonstrated (e.g. Byrne 1980; Cottrell 1985; Hiscock 1988). The direct translation of such models may not be appropriate in areas of relative resource abundance and associated low residential mobility, and consideration of specific socio-cultural factors. While Bribie Island is a neatly circumscribed, discrete geological and geographical entity, it is also part of a larger cultural landscape from which it cannot be dissociated. As outlined in Chapter Four, the networks within which the Joondaburri, along with other Island groups, and their mainland relations lived involved constant contact for social, economic, ritual and political purposes. Additionally, the Island's recorded role as a travel route between the mainland and Moreton Island involved frequent avenues for resource procurement. Conservation and rationing of raw materials is not evident because the types of raw materials available are all of high quality; that is, they comprise the highly siliceous materials as well as the fine-grained volcanics necessary for manufacture of conchoidally fractured artefacts. Coarser grained materials useful in the manufacture of the 'other artefact' category are also readily available. Although occasionally individual cores or cobbles may be poor representatives of a specific raw material or contain inclusions that adversely affect manufacture, the sources themselves are essentially sound.

As this study concentrated solely on Bribie Island, the results may well have been different if they had included not only the contiguous mainland but also Moreton and Stradbroke Islands. Although the studies reviewed in Chapter Two indicate that distance-decay or rationing patterns can be demonstrated over relatively short distances (in particular Byrne 1980; McNiven 1990), Bribie Island itself may be too small to exhibit this evidence (see Close 1996). In an extended study area I would expect to find patterns similar to those demonstrated by McNiven (1990) for Cooloola (approximately 70 km north of Bribie Island).

The multiple sources of raw materials - those on the mainland as well as on Moreton Island - may also serve to disguise any patterns of distance-decay. Burton reported similar findings '95% of Yorkshire flint axes are said to come from the Yorkshire coastal boulder clays (especially from shoreline outcrops) and the rest from dispersed chalkland sources, which makes it very difficult to use marketing patterns and distance-decay relationships as a means of investigating modes of exchange' (Burton 1980:141).

Given the circumstances of procurement, importation of raw materials/artefacts may not necessarily have been through the large semi-permanent residential sites but could have occurred at almost any coastal site. In the distance-decay/distance to source models discussed in Chapter Two, the quarries, sources or outcrops of raw material had been fairly specifically located or determined. There was therefore a specific point from which measurement of decay or rationing began, although as Hiscock and Clarkson (2000:102) point out 'there is no fixed rate at which assemblages change as knappers respond to altered access to replacement material'.

This study concentrated on the sites identified along the dune ridges, as well on the west coast (BI02, BI03 and BI11). BI09 is also close to the northern coast. With the exception of a single artefact site (BI04), there are no recorded sites on the east coast due to severe ongoing erosion. Sites would almost certainly have existed there, and their nature and content may be hypothesised on the basis of current knowledge. However any potential impact they may have had on a distance-decay model is purely speculative. There is also an absence of sites recorded for the north west of the Island, other than the coastal middens recorded by Stockton (1973) with canoe access along Pumicestone Passage. I do not believe this absence to be the result of inadequate survey or investigation of the area. The soil type there differs from that found over the clearly inhabited areas of the Island, and it is generally of lower elevation. My surveys of the area before the harvesting of the pine plantation found it to be almost park like in nature. Surveys I conducted after harvesting had commenced and the surface water levels had begun to rise revealing boggy waterlogged ground unsuitable for campsites. Petrie's Aboriginal informants had told him during the 1877 search for a site for government settlement 'that it was less suitable for settlement further north' (QSA LAN

5475/77). I interpret this to mean the area was unsuitable for occupation for any extended period for practical environmental reasons, although there may also have been pertinent cultural reasons.

Bribie Island may represent a palimpsest of regional use patterns (see Zvelebil *et al.* 1992). Bribie Island's location essentially at the centre of a dynamic socio-cultural and economic highway between the Bunya Mountains, The Glasshouse Mountains, Moreton Island and the associated mainland (see Chapter Four) may be a determining factor in the nature and explication of the stone assemblage data.

The data examined to test the hypothesised import point model can now be reviewed in order to establish what *was* happening on Bribie Island.

Stone artefacts on Bribie Island - a summary

The analysis results indicate that artefact manufacture occurred all over the Island. Both prepared and unprepared cores were imported and transported around; there was a moderate to high degree of core rotation; and the whole flakes on the eastern side of the central swamp were smaller than the flakes on the western side. Cores were more reduced on the eastern ridge, and manuports were generally heavier there.

The relatively low number of retouched flakes reflects the general characteristics of Australian assemblages. Flaked pieces are the most numerous technical category, and most of them (83%) are found on the eastern ridge. Their numbers are highest at the sites where split cones are also found. Cores are associated with split cone broken flakes at 13 sites, five on the western side of the Island and eight on the eastern side.

Although the greatest numbers of whole flakes are found on the eastern side (BI30, BI09 and BI16), site BI03 on the western coast yielded the greatest number of cores (n14).

The bevelled artefacts from Bribie Island are similar to those associated with processing of fern roots (such as *Blechnum indicum*) in the Moreton Region (e.g. Gillieson and Hall 1982; Kamminga 1981). Artefact distribution is the most restricted of all the categories in this study and may result from casual collection bias. The artefacts are generally much larger than flakes, they are chunky and obvious to the casual collector. Given the purported ubiquity of *Blechnum* in the diet of the Joondaburri and other Moreton Region peoples the bevelled artefact category is considered to be under-represented for post-depositional reasons. The characteristics of the 'other artefact category' are those of artefacts commonly associated with food or materials processing. Again the artefact numbers and distribution may be the result of casual collection bias and other post-depositional factors.

Raw Materials

Sources

The people of Bribie Island had to look elsewhere for the raw materials of their stone tool kits. Thirty raw materials have been identified for the artefact assemblage, the most abundant being silcrete. Other relatively frequent raw materials are quartz and chert, as well as various rocks of volcanic origin including basalt, rhyolite and trachyte. It was beyond the scope of this thesis to undertake petrographic analysis to specifically determine the raw material sources.

Silcrete, quartz and quartzite river cobbles have been identified in gravel pans at Sandstone Point, on the mainland close to Bribie Island (Cotter 1995:10; Kamminga 1981) although their primary location is yet to be determined. Silcrete outcrops also occur on Moreton Island (see Ross *et al.* in press), and certainly distinctive silcretes similar to those from Moreton Island are seen on Bribie. Other than silcrete, the predominant raw materials utilised on Bribie Island are volcanic or metamorphic in origin.

The Glasshouse Mountains are about 30km to the west of Bribie Island, and are clearly visible from the island. The Glasshouse Mountains are part of the North Arm Volcanics, the majority of which are exposed from Coolum westwards to Kenilworth and from Eumundi to Maleny (Willmott and Stevens 1988:6). Most of the Mountains are intrusive rhyolite and trachyte plugs, while some are large sills (e.g. Mount Tinbeerwah). Between the major intrusions are smaller dykes of similar rocks (Willmott and Stevens 1988:11). The plugs are unusually high in the alkali elements sodium and potassium, and the rhyolites and trachyte are quite distinctive. The light-bluish grey rhyolite (comendite) found artefactually on Bribie Island forms Mounts Tibrogargan, Coonowrin, Tunbubudla, Coochin, Saddleback, Wild Horse, Tibberoowuccum, Ngungun, Coolum, Cooroora and Cooran. Trachyte forms Mounts Beerwah, Beerburrum, and Miketeebumulgrai (Willmott and Stevens 1988). An outcrop of trachyte also occurs in the upper reaches of Lagoon Creek about 20km from Bribie Island (Cotter 1995:11).

Mount Pinbarren is of basalt, which also caps the Mapleton-Maleny and Buderim plateaux. Small scale granitic intrusions through the Landsborough and Myrtle Creek Sandstones between Maroochydore and Noosa have metamorphosed the surrounding rocks into quartzite (Willmott and Stevens 1988:9). Chert occurs in small amounts in the Kurwongbah beds, and in large amounts within the Neranleigh-Fernvale beds about 60km distant from Bribie Island (Cotter 1995:11). The silica mineral quartz is the second most common mineral on earth, and is found in all rock types (Mayer 1976:160).

Despite the lack of specific petrographic analysis, all the raw materials identified on Bribie Island occur within 60km of the island, both as primary sources (outcrops) and secondary sources such as cobbles in creeks and gravel pans (see Table 7.1). This is well within the geographic area of the groups with whom the islanders maintained social networks.

How were raw materials obtained?

I refer above to the primary and secondary sources of the raw materials found in the artefact assemblage on Bribie Island. In view of research into Aboriginal quarry sites (e.g. Hiscock and Mitchell 1993; McLaren 2002) I am confident in referring to both sources the primary and secondary sources as potential 'quarries' (while acknowledging that further research is required to identify *specific* quarry sites). Torrence (1986) demonstrated the socio-cultural importance of quarry sites (see also Binford and O'Connell 1977; Cottrell 1985; Gould and Saggers 1985; McBryde 1984); Ross *et al.* (in press) have recently developed this further in a specifically Moreton Region context. In the Ross *et al.* study, the quarries at Gunumbah (Cape Moreton) on Moreton Island

Table 7.1. Identified raw materials from Bribie Island and possible provenance.

Raw Material	Type	Possible Provenance
Andesite	Volcanic/intrusive	North Arm Volcanics
Basalt	Volcanic/intrusive	Mapleton/Maleny Plateau
Chalcedony	Silica mineral	North Arm Volcanics
Chert	Sedimentary	Kurwongbah Beds
Coffee Rock	Indurated sand	Bribie Island
Conglomerate	Sedimentary	Landsborough Sandstones
Granite	Metamorphic	Landsborough Sandstones
Granodiorite	Metamorphic	Landsborough Sandstones
Greywacke	Sedimentary	Landsborough Sandstones
Ignimbrite	Pyroclastic volcanic	North Arm Volcanics, Glasshouse Mountains
Jasper	Sedimentary	Kurwongbah Beds
MCS	Silica mineral/Sedimentary	North Arm Volcanics/Landsborough Sandstones
Mudstone	Sedimentary	Landsborough Sandstones
Ocherous Ironstone	Sedimentary/Oxide	Moreton Island/Glasshouse Mountains
Ochre	Sedimentary/Oxide	Glasshouse Mountains/ Landsborough Sandstones
Phyllite	Metamorphic	North Arm Volcanics
Porphyry	Igneous	Glasshouse Mountains
Pumice	Pyroclastic volcanic	Glasshouse Mountains
Quartz	Crystalline silica	Glasshouse Mountains
Quartzite	Metamorphic	Intrusions in Landsborough Sandstones
Rhyolite	Volcanic/intrusive	Glasshouse Mountains/North Arm Volcanics
Sandstone	Sedimentary	Landsborough Sandstone
Shale	Sedimentary	Landsborough Sandstone
Silcrete	See Chapter Six	Intrusions in Landsborough Sandstones/Sandstone Point/Moreton Island
Silicified Wood	Silica mineral replacement	Unknown; alluvial deposits
Skarn	Metamorphic	North Arm Volcanics
Slate	Metasedimentary	North Arm Volcanics
Trachyte	Volcanic/intrusive	Glasshouse Mountains
Tuff	Pyroclastic volcanic	North Arm Volcanics
Vesicular basalt	Volcanic	Mapleton/Maleny plateau
Volcanic	Volcanic	North Arm Volcanics

Note: This is not an exhaustive discussion of the types or formation processes of all of the raw materials but refers to the raw materials as they manifest in the Moreton Region/the assemblage. For example, rhyolite may also be formed pyroclastically but is not observed in this form in the study area.

are documented and discussed within an archaeological, anthropological and Aboriginal framework. Cape Moreton is one of the principal sources of a variety of raw materials, along with Point Lookout on Stradbroke Island (Richardson 1979; Ross *et al.* in press). Particular families within the Ngugi Aboriginal community (traditional owners of Moreton Island) strictly control access to the Cape Moreton quarry sites. Although some parts of the quarries consist simply of cobbles away from the major outcrops (similar to the secondary sources I describe above) collection and removal must be strictly within Ngugi tradition and Law (Ross *et al.* in press).

> In summary, the Cape Moreton headland is an area restricted to Ngugi family owners. Only those permitted by Law to enter this area for ceremony and stone collection are able to remove stone. The nodules are first tested by the traditional owners at Robins' Site 1 (the *Cape Site*) and are then brought to traders assembled away from the dangerous nature of the headland. In this 'marketplace' the traders test the raw material for themselves and make their choices, negotiating a price and participating in trade-related ceremonies involving food, including the ceremonially important dugong (Ross *et al.* in press:14).

Undoubtedly similar circumstances concerning access to and procurement of raw materials also obtained at the mainland primary and secondary sources (see Mulvaney and Kamminga 1999). Joondaburri procurement practices were 'embedded' in the broadest sense in the active social, economic, political and ritual networks of which they were part. Exchanges such as those described by Ross *et al.* would have taken place during large formal gatherings, as well as less formal encounters involving one or more family members from the Joondaburri and the owners or traders which were part of daily life. In exchange for stone, the Joondaburri would have provided both tangible and intangible goods (see McBryde 1984).

Chronology

Chronological control of open or surface sites is inherently problematic and establishing a chronology for the surface sites from which the current assemblage was collected is no different. A radiocarbon date obtained from a depth of 20cm at BI09 was 200±80 BP (Beta-56565, Smith 1992), and essentially recent. The shell associated with the dated material was in a similar condition to that observed surficially. Given the disturbed sandy conditions of most of the sites on the Island proper, and that traditional lifeways and practices had been disrupted since at least 1825, this date approximates with that of the observed surface material and that the sites are generally contemporaneous. Although earlier dates have been obtained from middens on the west coast (see Crooks 1982) these sites are neither contemporaneous nor analogous with the surficial residential/specific activity sites along the dune ridges.

What was happening on Bribie Island?

The technological analysis revealed spatial variations between artefacts on the western and eastern sides of the Island. Average whole flake length was less on the eastern side, as were the length of core scars. The eastern cores also tend to have more flake scars. Manuports on the eastern side were heavier than were those on the western side.

Bribie Island is a low risk environment with assured and abundant economic and socio-cultural resources. It afforded a relatively sedentary lifestyle to a population with a strong well-established self-identity as well as a dynamic role in equally well established socio-cultural networks (see Chapters Three and Four).

The evidence suggests that, with a relatively small number of retouched artefacts, artefact manufacture on the Island was opportunistic. This is fairly typical of Australian assemblages (see Chapter Two). The 'toolkit' is also fairly simple as befits exploitation of low risk resources and a sedentary lifestyle (Chapter Two). It does not necessarily resemble the highly reduced assemblages associated with high sedentism by Hiscock (1994), nor the expedient core technology associated with sedentism by Hiscock (1996) and Parry and Kelly (1987). Manufacture and maintenance occurred across the Island, but the evidence also indicates that artefacts were also imported. The differences noted in flake lengths and core scars on the eastern side of the Island suggest differences in the usage of the western and eastern dune ridges, although not in the use of the raw materials themselves. This lack of differential usage of raw materials is similar to that described by Morrow and Jefferies (see Chapter Two).

There are more sites recorded on the eastern dune ridges, but with the exception of BI09 the generally larger sites are on the western side of the Island (refer Table 6.1). The western ridges are close to the estuarine resources that played a prominent role in the subsistence economy, and also have easy access to the mainland. They are in what was originally a forested area suitable for camping (see Chapter Three) and lend themselves to residential occupation. Both sides of the Island do have sites at which the full range of artefacts were found suggesting that they were residential or base camps, but I do not think this negates the argument of greater residential occupation on the western side. Open heath and sedgeland (Chapter Three) largely covered the eastern side of the Island which, while useful for resource exploitation, would be less desirable for long term occupation (see Jochim 1976). There are gaps in the distribution of other artefacts and bevelled artefacts on the eastern side indicating that less processing of resources may have taken place there.

Of all the 43 sites, eight demonstrate the full range of artefact technical categories. These are BI09, BI35 and BI16 on the eastern side and BI03, BI11, BI49 and BI73 on the western side. BI67, also on the west, has all categories except manuports. I interpret the eight sites, with all artefacts, as semi-permanent residential camps at which all subsistence activities were undertaken. BI03, although recorded as an artefact scatter, is in close proximity to BI67 and I interpret them to be elements of the same site. Although these sites are close to the site of the 1877-1879 government settlement (the exact location of which is unclear), the nature of settlement life with a relatively small group of people reliant on rationing rather subsistence activities over a period of two years is unlikely to have impacted greatly on the archaeological record. The recorded area of BI16, on the eastern side, is fairly small (1600m^2) but this may be a factor of visibility. When the site was recorded the area was heavily forested with commercial pine.

Although exact import points for stone are undetermined, the west-east spatial variations suggest that most stone came into the western side of the Island (despite BI09's proximity to the mainland and the potential of Moreton Island as a source), because of its proximity to the mainland and ease of transport. As demonstrated in Chapter Three, the central swale or swamp was deeper and wider during the Aboriginal occupation of the Island, and presented a barrier to east-west movement for most of its length. This barrier was sufficient to cause the occupants of the eastern side to be more conservative in their use of raw materials than is evident on the western ridges.

The picture that emerges is one of the use of the western dune ridge as a 'residential' area with sites more or less evenly distributed along much if its length. On the eastern side, the residential camps are located at the northern end of the dune ridge (BI09 and BI35) and the southern end (BI16). Between these camp sites are scattered specific activity or short term resource exploitation areas. The presence of smaller whole flakes and more extensively reduced cores at the eastern sites provides further evidence of the differential use of these ridges the barrier swamp. The eastern cores may have been cached for use, rather than bringing 'new' cores for each visit, and consequently been reduced further than the western cores (see Chapter Two). The sites may have been used by travellers (see Chapter Four) who perhaps brought with them and discarded relatively reduced artefacts, or who may have taken advantage of cached materials to use along the way (cf. Binford 1979).

The spatial variations in the manuport weights remain mysterious. However the dominance of the manuport raw materials by ocherous ironstone and ochre suggest that they are not being transported for artefact manufacture. Clearly they have another role to play, perhaps in the extraction of pigments.

CONCLUSION

This study has shown that application of a distance-decay model to the stone assemblage on Bribie Island did not work. This is not a function of the model, but of the study area.

The study has confirmed a difference in the usage of the western and eastern sides of the Island. I suggest that this is a combination of the importation of the majority of stone through the west coast, and the barrier nature of the central swamp. The characteristics of the artefact assemblage are those of a relatively sedentary lifestyle in a low-risk environment with assured economic resources. These include rich estuarine, marine and plant resources as well as access to stone raw materials. The majority of the artefacts demonstrate opportunistic (or expedient) techniques of manufacture and reduction typical of exploitation of low risk resources and a reliable supply of raw materials. This supports previous interpretations of sedentism in the Moreton Region (see Chapter One). Although an expedient core technology associated with sedentism was not demonstrated, this is because the procurement of raw materials is 'embedded' in its broadest sense. While the population of Bribie Island may have been sedentary in terms of resource exploitation, it was socially and culturally mobile.

The Bribie Island study highlights certain further research considerations. While a spatial pattern of stone variability has been demonstrated, the relationship between the surface sites containing stone and those containing only shellfish remains need to better understood. Understanding of the chronology of Aboriginal occupation is still poor. Further excavation of sites along the dune ridges is required not only to determine temporal control for the Island itself but also to tie into sites on the mainland and on Moreton and Stradbroke Islands. Similarly, surveys on the mainland and the offshore islands need to be further extended to establish spatial patterning relative to stone sources. These may reveal patterns like those demonstrated by McNiven (1990) for the

Teewah area on the mainland north of the study area.

The value of an intensive analysis of stone artefact assemblages, such as that on Bribie Island, should be explored for sites on the mainland. Establishment of quarry locations and the testing of distance-decay models on more coastal would extend understanding of Aboriginal settlement in the Moreton Region. It is highly unlikely that, given the unique position of Bribie Island, the results of the stone analysis would be replicated elsewhere in the Moreton Region. Bribie Island may well be part of a distance-decay model - its place in the continuum just needs to be established. To do so was beyond the scope of this thesis.

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